Ecological Resilient Landscapes:

Averting a Pending Disaster

Jacob Berg

Design Thesis

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ECOLOGICAL RESILIENT LANDSCAPES:
Averting a Pending Disaster

A Design Thesis Submitted to the
Department of Architecture and Landscape Architecture
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By

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Date

TABLE OF CONTENTS

TABLE OF CONTENTS

THESIS ABSTRACT

Jacob B. Berg

TITLE

ECOLOGICAL RESILIENT LANDSCAPES: AVERTING A PENDING DISASTER

SUMMARY

Scars can be inflicted on landscapes after decades of human intervention. This project is meant to embrace the effects of remedial ecological design on our fragmented landscapes. Limited human intervention is an essential element in designing long-term, healthy environments.

Ecological resilience assists landscape architects in designing landscapes to respond to environmental disturbances such as pest epidemics. Steady state landscapes do not accommodate natural disturbances, ecological diversity and longevity. Disturbances strengthen a landscape's functional longevity by highlighting the complexities of biodiversity. Diverse ecosystems provide society with a natural balance between positive and negative pulses.

Silver Lake Park, a 100+ acre park, near downtown Rochester, Minnesota is currently a fractured landscape in an urban environment. It has potential to serve as a comprehensive landscape to illustrate effects of diverse functions and biodiversity in southeastern Minnesota.The design results of my research serve as a catalyst in promoting design that emphasizes ecological resilience, biodiversity and long-term landscape health.

KEYWORDS

Biodiversity, Ecological Resilience, Ecosystem

PROBLEM STATEMENT

Can design for biodiversity increase a landscape's ecological resilience?

STATEMENT OF INTENT

TYPOLOGY

Ecological resilient landscapes

THE THEORETICAL PREMISE / UNIFYING IDEA

CLAIM

Ecosystems within landscapes will degrade unless the landscape has viable microbial, animal and plant communities capable of sustaining themselves.

SUPPORTING PREMISES

Landscape architecture and horticulture professionals are "stewards of the land." They are responsible for protecting existing ecosystems based on biological diversity. Diverse ecosystems can then interrelate with each other to extend a landscape's viability and longevity.

Planning urban ecosystems restores ecological services by reconciling human needs and biological diversity. Ecological services are benefits from ecological functions of healthy ecosystems such as waste degeneration, water purification and soil generation.

Pest epidemics such as Dutch elm disease and emerald ash borer are proving that a majority of existing landscapes are not capable of confronting large scale disturbances.

Ecosystems within landscapes adapt to human intervention negatively unless the landscape has viable microbial and plant populations capable of sustaining themselves.

Landscapes are planned for long-term sustenance by focusing on the complexities of biodiversity and human interactions. Public parks provide human interactions including greenways, recreation trails and social events to demonstrate the park's benefits.

CONCLUSIONS

Ecologically resilient landscapes are planned to adapt to both environmental and human disturbances.

PROJECT JUSTIFICATION

Disturbed landscapes tend to develop fractured ecosystems, which are fragile and non-resilient to ecosystem pulses. The design of healthy, stable ecosystems is key to sustainable urban and agricultural environments to maintain ecological benefits for society. Degraded urban ecosystems are a pending disaster in which effective design can heal.

Today, landscapes are impacted on a global, regional and local scale. Globalization has introduced new insect and disease outbreaks once never imagined. These pests decimate regional ecosystems beyond a sense of recovery. Thus, landscapes can be affected locally, regionally, even globally. Ecologically resilient landscapes are gaining momentum with landscape architects; however, the general public fails to understand they exist. An ecologically healthy landscape has direct implications both in short and long term planning.

Bioregions connect landscapes, which are slowly becoming disconnected with an emerging global economy. Ecological and human inflicted pressures begin to connect landscapes at the bioregion level. Landscapes depend on their ecological complexities such as bioregions, biodiversity and microbiology to minimize any disturbances inflicted upon them by human, nature or wildlife causes. Our lack of far-sighted planning far sighted has left habitat fragmentation, diseased vegetation and aging infrastructure as an inflicted scar on our landscapes.

Managing our anthropogenic landscapes is another crucial phase of long term objectives. How will future landscapes be designed to consider management practices for the next 1, 2, 5, 10, 25 and 50 years? People enjoy public green spaces provided to them, but how can we engage the public to ensure ecological resilience? How are cities adapt to public park maintenance due to their benefits?

The effects of monoculture landscapes, depending on their scale, decrease the potential of our built environment. Small scale monoculture is able to be replaced if the plants used fail as design elements due to impending pests. We must begin to question: How can resilience be affected by techniques, management and design?

This thesis will investigate these questions on a much more detailed level in an attempt to develop a comprehensive answer facing landscape architecture. Can we design our landscapes with adaptability, management and long term sustainability to allow cities to properly maintain them in future landscape planning.

USER DESCRIPTION

THE CLIENT:
Rochester Parks and Recreation Department

The Rochester Parks and Recreation Department was founded in 1904 and serves as a crucial factor in public park management. Rochester's parks include over 3,500 acres of green space and 85+ miles of recreation trails (City of Rochester, 2010).

Rochester Forestry Department

The Rochester Forestry Department is responsible for managing urbans trees in public boulevards and parks. They maintain over 30,000+ boulevard trees, along with 30,000+ public park trees. Pest managment for Dutch elm disease, emerald ash borer and oak wilt are significant to healthy urban green spaces.

THE USERS:
Rochester Citizens: Surrounding Neighborhoods

Numbers:
The surrounding East Pioneers, Glendale and Northrup neighborhoods will have an estimated 2,500 to 5,000 park users.

Peak Usage:
People are most likely enjoying public green spaces during transitional seasons such as April to May and September through October (J. Berg, pers. obs.). However; public activities such as tree plantings, National Night Out and Rochesterfest activities are to be scheduled throughout the summer to engage young, middle aged and senior citizens.

Parking:
Currently, adequate parking is provided and many residents can access Silver Lake Park from all directions. Proposed greenway connections will make it easily accessible for pedestrians on major streets such as N. Broadway (Highway 63), W & E Silver Lake Dr. NE and 7th St. NE.

Physical Limitations:
The proposed public park will be designed in compliance with the 2010 Americans with Disability Act Standards for Accessibility.

USER DESCRIPTION

Regional Mayo Clinic Employees: Suburban and Rural Cities

Numbers:

1,000 daily Mayo Clinic employees from surrounding cities such as Byron, Eyota, Kasson, LeRoy, Saint Charles and Stewartville.

Peak Usage:

Typical Mayo Clinic employee schedule is from 7:30AM to 4PM. Employees are likely to use Silver Lake Park either during their lunch break or after work.

Parking:

Many Mayo Clinic employees are from the region and either carpool or drive their own vehicle. City buses are also located around the Mayo Clinic facilities, which will allow employees to visit Silver Lake Park.

Mayo Clinic Patients & Families: National and Worldwide

Numbers:

50-100 daily Mayo Clinic patients and families from around the United States and abroad.

Peak Usage:

Typical Mayo Clinic patient schedules are from 7AM to 5PM. Patients are likely to use Silver Lake Park in between clinical appointments when they may have several hours available.

Parking:

A majority of Mayo Clinic patients are not likely to have their own vehicles due to airline transportation. Public transportation is available for Mayo Clinic patients to transport from downtown bus shelters to Silver Lake Park.

SITE ECOLOGY:

Ecosystems:

Silver Lake Park has underlying elements crucial in the redevelopment of various ecosystems. The design solution will evaluate which areas of the landscape are suitable to specific ecosystems to coincide with user managment practices. In addition, transitional landscapes between each ecosystem will be designed to have the largest amount of biodiversity. It is in these ecoclines where "diversity and rarity are found due to gradual difference in at least one major environmental factor...Species interaction increase with two distinct ecosystems" (Van der Maarel, 1990). Indigenous plantings will be implemented in these ecosystems along with many newly transplanted trees, shrubs and herbaceous perennials.

Plant Diversity:

Monocultures are the typical status quo with many existing designed landscapes. "There is widespread evidence that heterogeneous landscapes, which resemble natural patterns, provide greater biodiversity" (Benton, 2003). The U.S.greens industry, due to a limited availability of adaptable tree species, planted American elms by the millions in the 1950's and 1960's. "Minnesota had close to 140 million elm trees by the time Dutch elm disease struck with [few additional species] lining its streets and streams. The predominance of elms, as the shade tree of choice, stretched from Iowa to Canada and Wisconsin to the Dakotas." Consequently, the preceding decades resulted in the rampant spread of Dutch elm disease. "During the decade of the 1960's a maximum effort would have prevented the disastrous losses of elm trees experienced by Minnesota in the 1970's" (U of MN Extension, 1993). Monocultures occured in the following decades and were unfortunately were continued as "design elements."

Biodiversity reduces dramatic changes in landscape composition. Landscape change often results in modifying historical disturbance regimes. Such changes can substantially alter vegetation structure and species composition (Hobbs and Huenneke, 1992), and may trigger cascades that cause fundamental and potentially irreversible changes to ecosystems (Hobbs 2001). An ecosystem responds to positive and negative ecological pulses. More generally, "by providing multiple species that fulfill similar functions but have different responses to human landscape modification, biodiversity enhances the resilience of ecosystems" (Walker 1995).

Frank S. Santamour, Jr. of the U.S. National Arboretum recommends the "following 10-20-30 guidelines for tree diversity: (1) plant no more than 10% of any species, (2) no more than 20 % of any genus, and (3) no more than 30 % of any family. A landscape with a variety of species will typically suffer fewer losses when a pest outbreak does occur" (Santamour, 1992).

SITE ECOLOGY:

Management:

Management is essential to any successful landscape's longevity and any potential pest epidemics. Managment guidelines will be compiled to evaluate and evenly distribute trees during specific year intervals to allow constant tree coverage in case of any potential epidemics. Existing tree species are currently being analyzed to determine 1. tree age, 2. tree species and/ or cultivar and 3. estimated year tree was planted. In return, activities to engage the public in voluntary tree plantings at the site yearly will balance Silver Lake Park's ecosystem longevity.

GREEN CONNECTIONS:

Pedestrian and Biking Accessibility:

Existing site conditions pose many difficulties to access Silver Lake Park by surrounding neighborhoods without a vehicle. Proposed greenways will directly connect Silver Lake Park with existing parks to reduce habitat fragmentation along with increasing public safety.

Central Median Planters:

Raised median planters are to be constructed on Broadway, West and East Silver Lake Dr. and 7th St. NE. The design objective is to slow vehicular traffic to create a short and safer distance for pedestrians accessing Silver Lake Park.

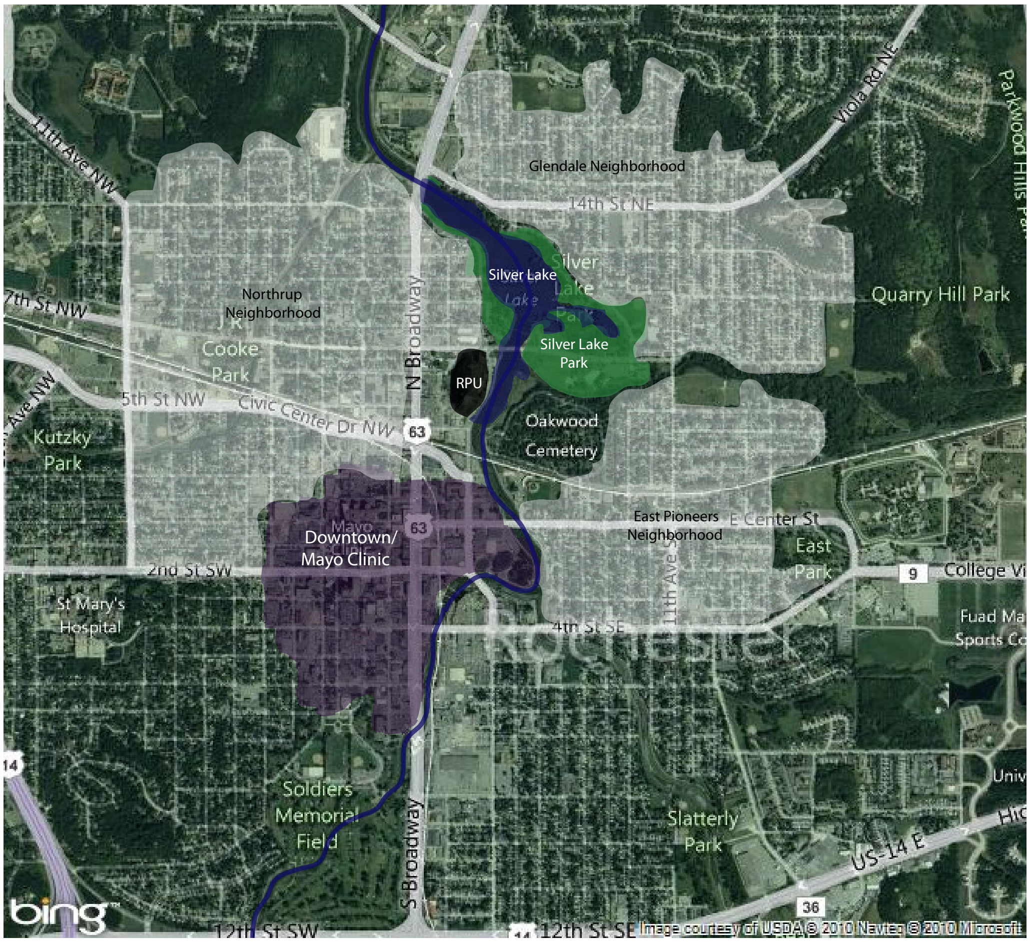
MACRO: REGION

Minnesota is located in the upper-Midwest region surrounded by North Dakota, South Dakota, Iowa, Wisconsin and Ontario Canadian Province. Three distinct ecosystems in Minnesota include coniferous forests, tallgrass prairies and deciduous forests. Specifically, southeast Minnesota has scattered oak savannahs and tallgrass prairies.

Southeast Minnesota has great differences between summer and winter temperatures. Extreme winter temperatures ranging from -20 to -40 degrees and summer from 85 to 95 degrees F. provide challenges to plant adaptability. The region is influenced by three air masses: the Maritime Polar (dry, mild), Maritime Tropical (moist, warm), and Continental Polar (dry, cold). Total annual precipitation ranges from 24 to 32 inches across southeast Minnesota. Annual snowfall averages 44 to 48 inches. Low winter precipitation well below 44 inches accounts for stress on many tree species and may increase the potential for spring fires, which are important for maintaining prairie and savannah conditions (Albert, 1995).

SITE INFORMATION

MACRO: CITY



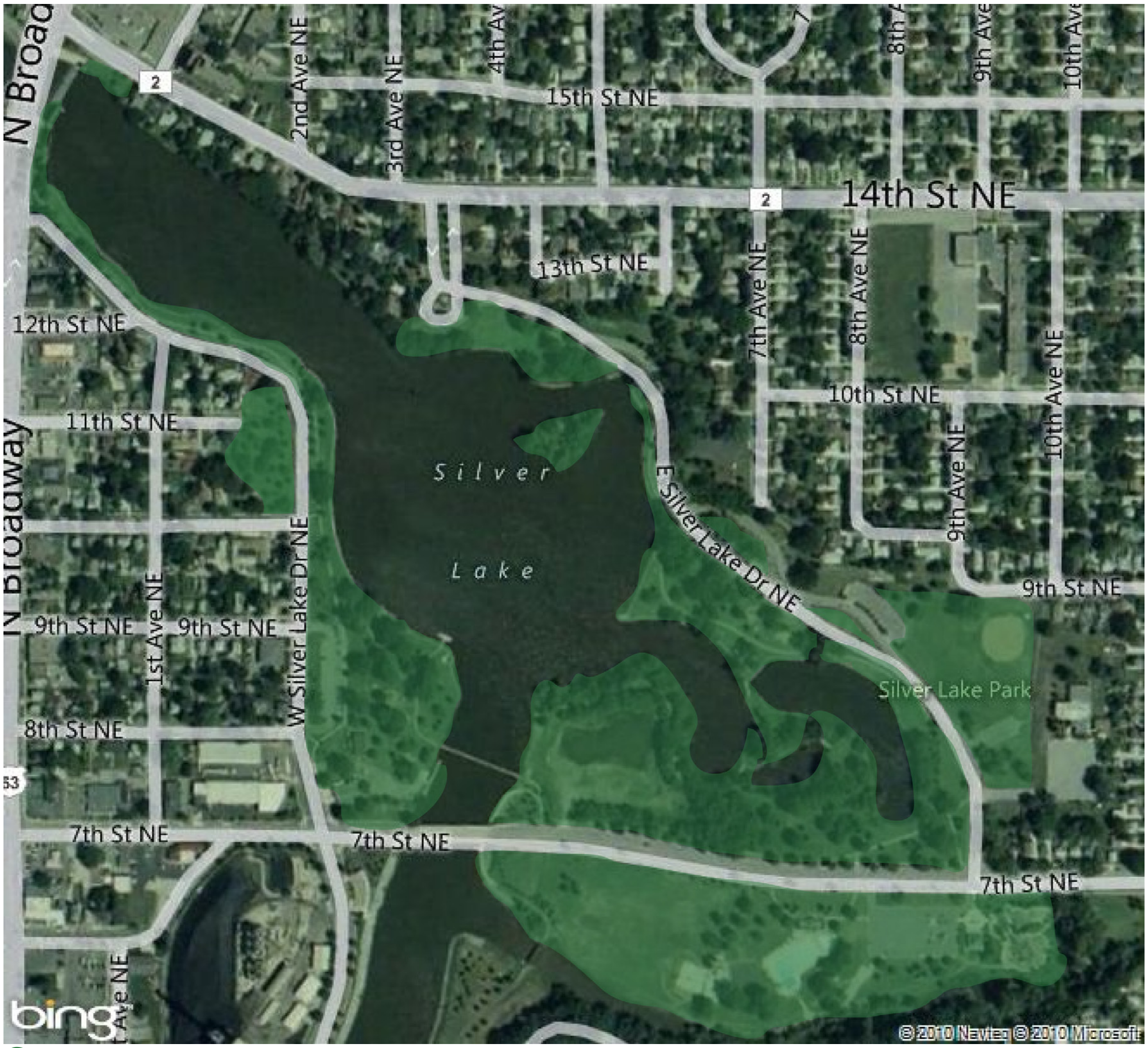
Rochester, Minnesota is located in Olmsted County, roughly 70 miles southeast of St. Paul-Minneapolis. Its population recently exceeded 103,000 with 50,000 rural residents living within an hour commute. Rochester is the third largest city in Minnesota behind Minneapolis and Saint Paul.

Zumbro River is a main river tributary of the Mississippi River that runs through downtown Rochester into Silver Lake. Silver Lake is a 38 acre reservoir owned by Rochester Public Utilities (RPU) (MN DNR, 2010) used for flood mitigation. North Broadway, 1st St NE, 7th St. NE and 14th St NE are existing roads which increase plant and wildlife habitat fragmentation.

Urban development has led to increased pollution runoff into Silver Lake and Zumbro River. Three high density residential neighborhoods converge with the urban downtown district expanding northeast towards Silver Lake.

SITE INFORMATION

MICRO: SITE



Silver Lake Park is a 100 acre public park, along with a 38 acre lake reservoir. It is located a mile northeast of downtown Rochester, approximately 92˚27'west longitude and 41˚01' north latitude. East Pioneers, Glendale and Northrup neighborhoods surround Silver Lake Park.

East Pioneers: South and Southeast
Glendale: East, Northeast and North
Northrup: Northwest, West and Southwest

Giant Canadian geese, a subspecies of Canadian geese, are a cultural identity to Rochester, Minnesota. According to the MN DNR, "1,000 to 2,000 resident geese reside in Rochester on a year round basis with a winter peak of 35,000."

PROJECT EMPHASIS

Landscapes have traditionally utilized ecology in design of various scales. Ecological landscapes have deteriorated over the past century in a majority of designed landscapes. Ecologically resilient landscapes incorporate biodiversity of plants, microorganisms and wildlife, along with long term management practices. The emphasis of this design project will be to develop and propose an innovative approach to ecologically resilient landscapes that engages the public's interest and is adaptive to a changing urban environment. An innovative landscape focusing on biodiversity will produce a final design solution that successfully meets the needs of the current user group(s) management practices in 5, 10, 20, 30+ years. Answering questions of technique, management and design implementation in regards to biodiversity are important components in the development of an ecologically resilient landscape.

A PLAN FOR PROCEEDING

DEFINITION OF A RESEARCH DIRECTION:

The thesis is ensured to be comprehensive, relevant and useful by investigating: the theoretical premise, unifying idea, project typology, historical context, site analysis and programmatic requirements.

DESIGN METHODOLOGY:

The thesis research follows a Mixed Method Quantitative/ Qualitatitive Approach, which employs a Concurrent Transformative Strategy with both quantitative and qualitative analysis. Premises developed in the Theoretical Premise/ Unifying Idea guides the perspective of this strategy.

Mixed method quantitative analysis from ArcGIS and USGS databases will include site hydrology, soil composition, geology, vegetation and land uses. The Rochester Planning Department website is a resource providing land use maps and neighborhood information. Site history will be provided on microfilm at the Rochester Public Library. Sanborn fire insurance maps will be archived for Silver Lake's history from 1890 through 1920. Additional site history will be available from Rochester Public Utilities. Scientific data, on the other hand, is information gathered through document research provided by the NDSU library database.

Mixed method qualitative data will be gathered from direct observations, tree measurements, local interviews and archival research. The data types collected will be determined by the specific research requirements of each underlying premise. The research will yield information to be analyzed, interpreted and reported at different phases of the research process. Research information will be presented by both text and graphic illustrations and be a foundation for a knowledge base essential to successfully complete the goals of the project.

A PLAN FOR PROCEEDING

DOCUMENTATION OF THE DESIGN PROCESS:

A developed and organized design process requires the implementation of numerous types of media. Various methods will be employed to ensure accuracy and comprehensive documentation. Site photographs from March to November 2010 will be organized onto files labelled with the site visit date. Photographs will then be accessible for the site inventory and photomontages. Electronically produced materials such as drawings, illustrations, renderings and photographs will be stored electronically by saving copies of each individual work to a separate folder. Any physically produced materials such as hand drawings and sketches will be saved both electronically and physically. Materials will be digitally scanned or photographed and stored in the same folder containing copies of electronic materials. Original drawings and sketches will then be placed in a folder for future reference. Interviews with neighborhood residents will be typed in a microsoft word document and applied to the final design solution.The process of duplicating and saving electronic and physical materials will occur weekly to ensure project completeness.

The final design solution will be presented on Adobe PDF boards in the Klai Hall immersive lab. Preceding research and design that was influential to the final design process will be compiled and preserved in a bound thesis. In addition, a PDF of the final thesis will be digitally uploaded to the Archives at the NDSU Main Library. The bound thesis will then be catalogued at the NDSU Klai Juba Architecture and Landscape Architecture Library to be used by future scholars.

PREVIOUS STUDIO EXPERIENCE

LA 271: Fall Semester 2007
Landscape Architecture I: Residential Design
Instructor: Kathleen Pepple

Kennedy Court Vacant Lot – Fargo, ND
Klai Hall Landscape- Fargo, ND

LA 272: Spring Semester 2008
Landscape Architecture II: Regional Park Design
Instructor: Mark Lindquist

Pioneer Park – Valley City, ND
Point Douglas Neighborhood- Winnipeg, Manitoba
Ready-Mix Concrete Design Competition

LA 371: Fall Semester 2008
Landscape Architecture III: Site Topography
Instructor: Stevie Famulari

Fargo Dike & Island Park – Fargo, ND
Symphonic Alley- Fargo, ND

LA 372: Spring Semester 2009
Landscape Architecture IV: Community Design
Instructor: Kathleen Pepple

Roy & Susan Evan's Residence – Fargo, ND
Lion's Club Park- Battle Lake, MN

LA 471: Fall Semester 2009
Advanced Landscape Architecture I: Urban Design
Instructor: Mark Lindquist

Triangle Park – Portland, OR
Buckman Neighborhood- Portland, OR

LA 472: Spring Semester 2010
Advanced Landscape Architecture II: Phytoremediation
Instructor: Stevie Famulari

Acid Canyon- Los Alamos, NM
Hesco Basket Flood Mitigation Design Competition- Fargo, ND

LA 571: Fall Semester 2010
Advanced Landscape Architecture III: Environmental Planning
Instructor: Catherine Wiley

Sheyenne National Grasslands/ Bison Reintroduction and Prairie Restoration- McLeod, ND

Biodiversity is a topic many people may recollect or have forgotten from a past biology or ecology course. "Biodiversity is the totality, over time, of genes, species, ecosystems or region, including the ecosystem structure and function that supports and sustains life" (Ahern et al., 2006). The scope of biodiversity also implies the diversity of ecosystems and regions. Its significance is becoming more evident in the conventional planning of urban landscapes. "Over the past fifty years, we have reduced a complex and diverse landscape into an asphalt network stitched together…out of a dozen or so crude design templates" (Ryn and Cowen, 1996). Agriculture has strong historical roots in our society and has influenced people's acceptance of limited biodiversity.

Integrating biological and ecological information with the planning and design process will contribute to a better balance between land use and the natural environment and will increase the public's awareness of biodiversity values to humans.

The following design propositions serve as major principles of ecological design in relation to landscape architecture and planning.

Design Propositions:

1. Biodiversity planning is in demand in rural, suburban, and urban areas.

2. Landscape architects and planners will play a larger role in biodiversity planning and restoration ecology as non-degraded habitat becomes scarce.

3. Biodiversity goals that are explicitly a part of a project's goal or design process are more likely to be achieved.

4. Integrating biological and ecological information with the planning and design process will contribute to a better balance between land use and the natural environment and will increase public awareness of biodiversity values to humans.

RECONCILING HUMAN NEEDS & BIODIVERSITY

People are unaware of ecological processes that are major constituents for human survival- food, water and air. Our food, water and air sources link to a landscape's ecology whether it is aging soil horizons supporting our food, wetlands purifying water or plants photosynthesizing carbon dioxide and producing oxygen. The preceding ecological processes are essential to the relationship between neighborhoods and urban parks. Human manipulation of natural landscapes has "depleted water quality, inhibited soil mineral/ organic nutrient cycling and altered the structure, organization and development of plant communities" (Lindenmayer, 2006).

Ian McHarg, a world renowned landscape architect, illustrated ecological design principles in his 1969 book "Design with Nature." An environmental analysis of site vegetation, soil composition, hydrology, history, geology, land use and topography acknowledges the importance of ecology in the health of urban landscapes. McHarg challenged conventional design in the 1960's to incorporate land-use planning of "what a landscape wants to be" into landscape planning (Ryn and Cowen, 1996). It was during this decade the importance of converging the environment with planning was recognized by biologists and conservationists.

A resilient urban landscape has the capacity to alter neighborhood communities through ecological design. A changing neighborhood can also transfer its resiliency back into the urban park to reduce distinct road boundaries. Ecological design is "any form of design that minimizes environmentally destructive impacts by integrating itself with living processes" (Ryn and Cowen, 1996). Design knowledge neglecting ecological services of soil, water and air can undermine our efforts for a resilient landscape. Ecological design has the potential to increase the resiliency of urban landscapes. Planting diverse and site-specific plant communities makes an urban landscape capable of adjusting to major disturbances such as insect or disease pathogens. Landscapes are more inclined to an ecological collapse as plant and animal species disappear from the system.

Landscapes must be designed for the maintenance of biodiversity - the variety of plant and animal species and their habitats. In a 1998 American Museum of Natural History survey, Biodiversity in the Next Millenium, "70 percent of scientists believe during the next thirty years, as many as one-fifth of the species alive today will become extinct." More importantly, biologist E.O. Wilson summarizes, "the number of species doomed each year is 27,000. Each day it is 74 and each hour 3." The decline of biodiversity is accelerated by traditional and conventional design not considering nature is "fundamentally erratic, discontinuous, and unpredictable" (Ryn and Cowen, 1996).

Water quality has been physically degrading due to urban runoff. Urban runoff has replaced riparian buffers, which balance water pollutants. In return, water pollutants directly affect a site's plant, animal and microbial communities. Soils are fragile compositions that are susceptible to damage whether it is through drastic grade changes or construction.

Soils require plant roots, wildlife and microorganisms for pedogenesis or soil formation over time. Landscape construction "limits root penetration, mycorrhizal growth, water infiltration and the exchange of atmospheric gases" (Ryn and Cowen, 1996). The ecological services or benefits to humans are numerous, although go unrecognized by the public and a majority of conventional planning. Urban ecosystems have been altered by humans for hundreds of years. "Conventional design and planning have not led to responsive, ecologically sound plans and design" (Lindenmayer, 2006). Humans have adjusted to the perspective that our environmental impact will only have minimal consequences. Agriculture has reconfigured many existing landscapes for the past several centuries as humans cultivated much arable land. Our human modifications of natural patterns of a site have minimized ecological services, increased habitat fragmentation and set the stages for a pending disaster.

LARGE SCALE DISTURBANCES

Urban ecosystems proceed through adaptive cycles, which involve cycles of system disruption, reorganization and renewal. An ecosystem can experience a major disruption, which can either regenerate it or transform it into a new state. "The long-term stability of systems depends on changes that occur during critical phases of cycles of long-term change" (Holling, 1986).

Today, landscapes are affected by human interventions. Contemporary design approaches have only touched the surface for regenerative cycles to include minimal site grading, storm water management and plant preservation. Ecological design needs to go beyond "the modest goal of minimizing site destruction to one of facilitating site recovery by reestablishing processes necessary to sustain natural systems" (Lindenmayer, 2006). Landscapes are holistic systems influenced by both biotic and abiotic factors. Biotic factors such as predators and diseases maintain a systematic balance. For instance, the dominance of American elms to create a street canopy in the early 20th century has led to an ecological succession. Dutch elm disease then emerged and served as a major disturbance, which catalyzed an ecological collapse. Green ash was then planted by the millions to counteract the declining elm populations. The disturbance has affected these "design elements" and history is ready to repeat itself with the ash monoculture and impending emerald ash borer disaster. People's acceptance of biodiversity is more inclined to change due to the negative connotation associated with monocultures. Past landscape designs have failed to realize that "nothing exists in isolation and everything is interconnected" (Lindenmayer, 2006). Natural habitats are surrounded by a fabric of developments. Human intervention can promote ecological successions in urban landscapes.

Urban landscapes have excess impermeable surfaces, which are disproportionate to minimal public green spaces. Landscapes have traditionally been designed without regard to environment, which resulted in a "destructive rather than regenerative cycle" (Ryn and Cowen, 1996). People serve as ecological pressures to an urban ecosystem. Ecological succession is "the directional change in community composition and structure over time" (Gurevitch et al., 2006). Four random environmental influences are adaptive to ecological design according to Sim Van der Ryn in Ecological Design.

1. **Genetic uncertainty**, or random changes in genetic makeup…which alter the survival and reproductive capabilities of individuals.

2. **Demographic uncertainty** resulting from random events in the survival and reproduction of individuals in populations

3. **Environmental uncertainty** due to unpredictable changes in climate, weather, food supply, and the populations of competitors, predators, pests, etc.

4. **Catastrophic uncertainty** from such phenomena as hurricanes, fires, droughts, etc, which occur at random intervals.

Adaptive cycles contain four phases: release, renewal, growth & conservation. Silver Lake Park experienced several historic floods, which serve as a 'release' to the urban environment. The summer 1978 flood in southeast Minnesota changed the soil composition due to the extended saturation of soil pores. Turfgrass was the most affected due to its shallow root system, which affected the main food source for Giant Canadian geese. Trees, on the other hand, are able to tolerate extended spring flooding depending on the species. "The longer trees are exposed to flooding, the greater the potential for injury. Short periods of [several hours to a week] of flooding during the growing season can be tolerated by most trees, but if flooding is recurrent or uninterrupted...serious damage to trees may occur" (Iles, 2008). Oxygen is not able to penetrate plant roots when flooding saturates soils. Pollutants such as petrochemicals, salts and sediments from surrounding roads are then transferred back into Silver Lake with receding waters. Flood contaminants are detrimental to plants based on concentration levels. A majority of plants are not able to live with high concentrations of pollutants such as nitrogen dioxide and sulfur dioxide. In addition, urban runoff concentrates flow and velocity to move water as soon as possible. Silver lake dam is an engineered solution that increases sediment loads, water volume and velocities. Engineered dams are solutions that treat water as a commodity by following current regulations rather than focusing on large scale, regional hydrology. A site's past, present conditions and future direction are essential to understanding and designing an ecologically resilient landscape.

LONG-TERM LANDSCAPE PLANNING

Landscapes have a role in maintaining ecosystems and can be implemented in design by the following guideline: "Think Big, Think Connected, Think Whole" (Ryn and Cowen, 1996). Vegetation is a physical site feature that maintains both plant and wildlife richness to include producers, consumers and decomposers. Traditional and contemporary landscapes tend to use vegetation as a separation boundary rather than one for identity. These ecological landscapes based on their scale, serve as "buffers against cascades of disaster and disease epidemics" (Levin, 1998). Small isolated ecological corridors are the most susceptible to the destructive effects of habitat fragmentation. Habitat fragmentation is subject to the strong influences of the "edge effect." The edge effect is the "systematic differences between areas inside the edges of habitat patches and the interiors of those patches" (Guveritch et al., 2006). Edge plants are exposed to more variable biotic and abiotic conditions such as strong winds, available light, herbivores, pollinators and seed dispersers. Specifically, plant and wildlife corridors are able to maintain continuity through "conservation, regeneration and stewardship" (Ryn and Cowen, 1996). However; plant and wildlife corridors can be "twofold: it is wasteful of land and resources if the objectives have little chance of being achieved, and it devalues the concept and legitimate need for landscape connectivity in conservation" (Bennett, 1999). Fragmented landscapes are minimized by the utilization of long-term design goals.

1. Create strategies to reconnect fragmented landscapes and design beyond a site's boundaries.

2. Maintain viable populations of indigenous plant and animal communities.

3. Protecting native ecosystems in a range of successional stages.

4. Adapting to regional landscape disturbances such as ecological fire regimes, hydrological cycles and movement patterns.

Ecological corridors are also influenced by human land-use intensity. Land-use intensity "reaches a certain point then the system moves from being controlled by biotic and abiotic factors toward human preferences" (Hope et al., 2003). Ecologically resilient landscapes have more constructive order between land use and human environment. A landscape's resilience is not effective, "until our everyday activities preserve ecological integrity by design, [while traditional design's] cumulative impact will continue to be devastating" (Ryn and Cowen, 1996).

Cities are also directly responsible for an unprecedented global decline in biodiversity. Species heterogeneity in landscapes has declined due to the design manipulation of urban ecology. More importantly, "heterogeneity present in cities is probably a result of a wide range of different management objectives and practices" (Grimm and Redman 2004, Barthel et al., 2005).

THEORETICAL PREMISE RESEARCH

Landscapes have a role in maintaining ecosystems and can be implemented in design by the following guideline: "Think Big, Think Connected, Think Whole" (Ryn and Cowen, 1996). Vegetation is a physical site feature that maintains both plant and wildlife richness to include producers, consumers and decomposers. Traditional and contemporary landscapes tend to use vegetation as a separation boundary rather than one for identity. These ecological landscapes based on their scale, serve as "buffers against cascades of disaster and disease epidemics" (Levin, 1998). Small isolated ecological corridors are the most susceptible to the destructive effects of habitat fragmentation. Habitat fragmentation is subject to the strong influences of the "edge effect." The edge effect is the "systematic differences between areas inside the edges of habitat patches and the interiors of those patches" (Guveritch et al. 2006). Edge plants are exposed to more variable biotic and abiotic conditions such as strong winds, available light, herbivores, pollinators and seed dispersers. Specifically, plant and wildlife corridors are able to maintain continuity through "conservation, regeneration and stewardship" (Ryn and Cowen,1996). However; plant and wildlife corridors can be "twofold: it is wasteful of land and resources if the objectives have little chance of being achieved, and it devalues the concept and legitimate need for landscape connectivity in conservation" (Bennett, 1999).

The following modified urban ecology principles are necessary to maintain urban landscape connectivity in A.F. Bennett's 1999 publication, *Linkages in the Landscape: The role of corridors and connectivity in wildlife conservation*.

1. Create strategies to reconnect fragmented landscapes and design beyond a site's boundaries.

2. Maintain viable populations of indigenous plant and animal communities.

3. Minimizing the impact from surrounding land use.

4. Promoting connectivity of natural habitat to counter the effects of isolation.

RESEARCH SUMMARY:

This research has illustrated the vast array of design knowledge necessary for ecologically resilient landscapes. Urban landscapes contain a multitude of biological complexities impacted by both humans and the environment. Design propositions have been proposed to serve as guidelines for designing an urban park in correlation with surrounding neighborhoods. Landscape connectivity in traditional and contemporary planning has resulted in human manipulated sites with a decreasing reliance on ecological services.

More importantly, these findings provide a solid basis for the ideas proposed within the theoretical premise and design assumptions. The following paragraphs will explain the organization of the research as well as summarize the various findings.

The research focus was on biodiversity and it's relation to urban parks and neighborhoods. It was first essential to understand the fragile balance that remains from designs over the past century. Our human survival needs ecological services to provide food, water and air. People do not fully understand our ecological impact has on biodiversity in providing us with our short and long-term needs. The development of urban infrastructure to connect cities has divided rather than united landscapes. Habitat fragmentation, degraded water quality and soil compositions are several design results that have accelerated the deterioration of biodiversity. Traditional and contemporary design elements have chosen not to immediately acknowledge professionals such as Ian McHarg who designed for minimal ecological impact.

Disturbances were highlighted to express the effects of environmental variability on urban ecology. Humans have accelerated major disturbances such as flooding by minimizing ecological processes. In addition, our short sightedness in ecological design over the past decades has achieved monotonous landscapes which are dominated by agriculture. Dutch elm disease is a well recognized identity of monocultures across the United States. Urban ecology used American elms as a design element that were replaced by a succession of monoculture- green ash. The impending emerald ash borer disaster has potential ecological consequences that will catalyze the way landscape architects design. Past and current design has limited our future choices through engineered solutions that treat ecological services as a commodity instead of a delicate resource. Ecological processes have been constrained by design choices that insisted for decades that ecosystems could adapt to significant changes. Site boundaries have served as separation, which has inhibited a holistic design approach to landscape connectivity.

The research concluded with a discussion on landscape connectivity within urban ecosystems. Can we design our landscapes with adaptability, management and long term sustenance to allow cities to properly maintain for future landscape planning? These three design elements are answered in designing long-term solutions at a broad scale that addresses a multitude of underlying ecological processes. Urban landscapes will continue to fall victim to ecological collapse until landscape planning begins to have a renewed focus on ecological services that affect our everyday needs.

TANNER SPRINGS PARK: 2004 - Present

Portland, Oregon NW 10th Ave & Marshall St

Tanner Springs Park consists of a natural Oregon landscape that is located in the Pearl District of Portland. Pearl District was a wetland prior to urban development in Portland. The wetland was fed by streams running down hills in southwest Portland. These streams were naturally filtered by wooded hillsites that cleansed the water as it made its way to the Willamette River. Water moved into the shallow basin of Couch Lake prior to reaching the Willamette River. Couch Lake existed under the current Pearl District but was developed as Portland's population expanded in the 19th century. The current park is built 20 feet above the former lake's surfaces. "Tanner Springs was rerouted through an underground system of pipes to the Willamette River."

"Peter Walker & Partners, a landscape architecture firm, was retained to provide concepts for three new parks between Tenth and Eleventh Avenues in the River District in June 1999" (City of Portland, 2010). Atelier Dreiseitl, a renowned German design firm, and GreenWorks, P.C., an award-winning, local landscape architecture firm, were selected to design the park.

DESIGN PROCESS

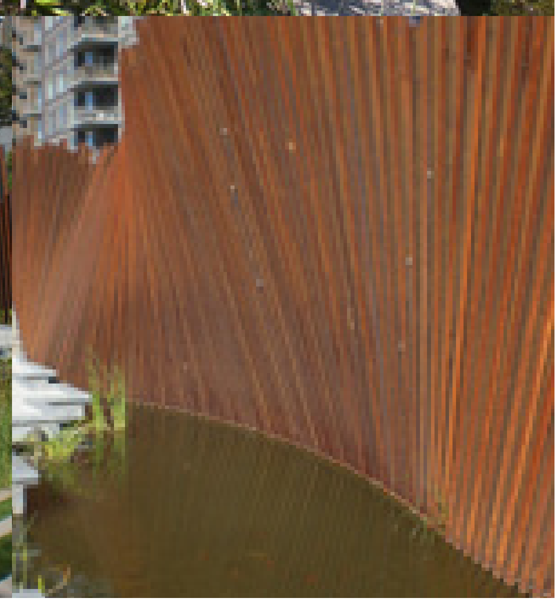
Construction of Tanner Springs Park began in June 2004. Public community meetings were held to ask for public suggestions of a permanent name for the park. Tanner Springs was adopted after committee review in April 2005.The springs connect the park to Tanner Creek that at one time flowed openly through this area. Tanner Creek was transported through large pipes beneath the city streets.

Tanner Springs Park design analyzed the historical significance of the site's regional hydrology from Tanner Creek to Lake Couch to the Williamette River. Similarly, Silver Lake Park in Rochester, MN has history hidden within its landscape. The Zumbro River was previously the only existing site water body until the Silver Lake reservoir excavation in 1936.

TANNER SPRINGS PARK:
Portland, Oregon

The spatial scale of Tanner Springs contrasts with the 100 acres of Silver Lake Park. However, ecological services such as water purification are evident to the general public. Tanner Springs Park is an illustration of how ecological processes can be made noticeable to urban park users. A majority of the public are use to a mosaic of hardscapes with minimal green spaces. Nineteenth century planning illustrated short-term objectives for the landscape without accomodating future development. Tanner Springs Park has long-term planning in mind while still being dependent on its maintenance. Tanner Springs became an engineered solution by transferring water underneath existing infrastructure. Ecological processes must become evident to site users in order to minimize adverse effects in future design and planning.

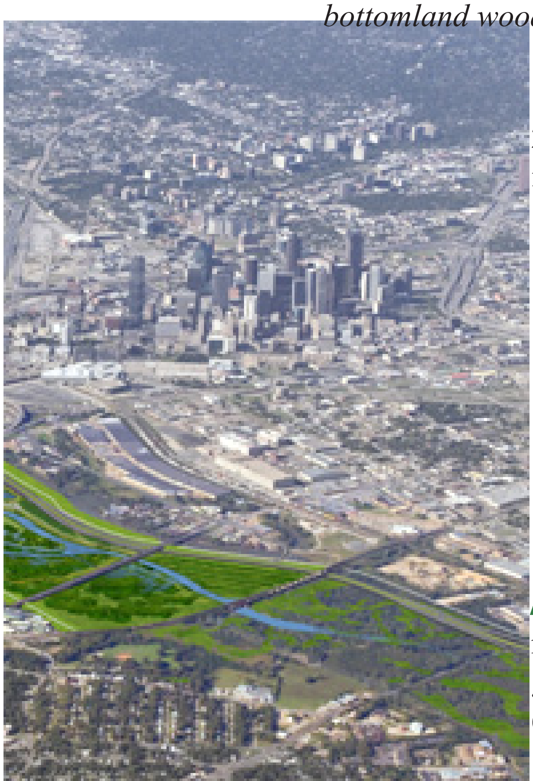
Silver Lake Park had riparian buffers replaced with a concrete pond liner and riprap. Limited areas within the park now consist of riparian buffers to control pollutant loading into Silver Lake. Tanner Springs has approximately three quarters of an acre dedicated to water purification through a naturalized creek. The landscape manipulates the formal placement of deciduous trees while merging with a wetland plant community.



TRINITY RIVER CORRIDOR: Under Construction

Wallace Roberts & Todd, LLC, Dallas, Texas

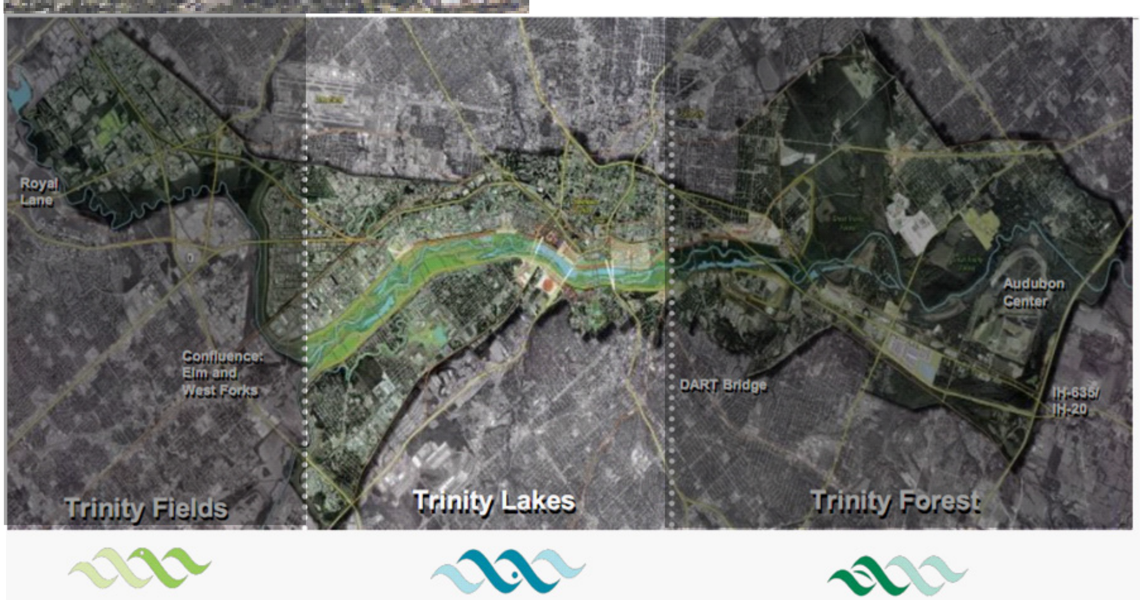
Trinity River Corridor located in Dallas, Texas has a river channel coursing down the middle of a 2,300-acre mostly inaccessible, barren floodway. The floodway is separated from the city by 35-foot earthen levees—a barrier between Downtown Dallas to the east and residential communities to the west. Approximately eighty percent contain minimal maintenance landscapes that can naturally withstand flood events: *prairie grasses, wetlands, riparian buffers, bottomland woodland and recreational lakes.*



Eco-Types: About 90 percent of the park's 2,300 acres will become a newly made landscape including:

- Mowed turf (13%)
- Meadow (32%)
- Bottomland woodland (10%)
- Riparian river terraces (3%)
- Wetlands (13%)
- River (10%)
- Lakes (12%)
- Urban parkland (7%).

All proposed plant compositions and species are native or naturalized, designed to evoke the full gamut of the Texas Blackland Prairie landscape (ASLA 2009).



TRINITY RIVER CORRIDOR:

Trinity Lakes Park: Dallas, Texas

Trinity Lakes Park relates to Silver Lake in its regional context to a downtown district. Urban ecology is implemented with site specific bioregions, which minimize unnecessary mowed turf. Rivers divide both landscapes between downtown and residential communities.

PROJECT GOALS

Natural Lake

Imagery of the eco-restorers

1. A landscape that is at once ecologically viable, educational, offering diverse opportunities for recreation and exercise, and functioning as a connective tissue between adjoining communities.

2. A landscape that provides a high degree of ecological service, from carbon sequestration, water recycling and bio-filtration, to the production of energy from renewable resources.

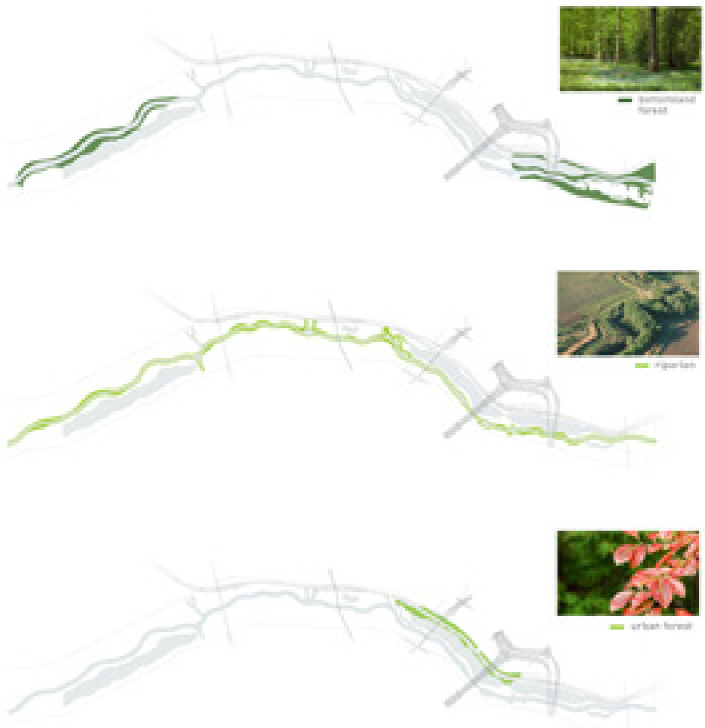
3. A landscape that restores access and beauty to the Trinity River, and enhances the floodplain as an expression of the Texas Blackland Prairie.

4. A landscape that integrates infrastructure — power transmission, transportation, flood protection and conveyance — within the context of ecology and recreation.

5. A landscape that embraces art, from the conception of landforms and its material quality to the provision of venues for major works — permanent and temporary. (ASLA 2009).

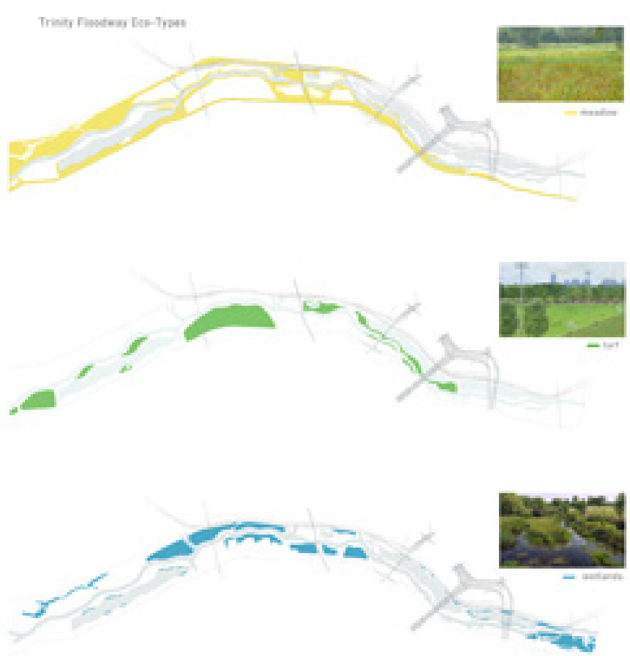
TRINITY RIVER CORRIDOR:

Trinity Lakes Park: Dallas, Texas



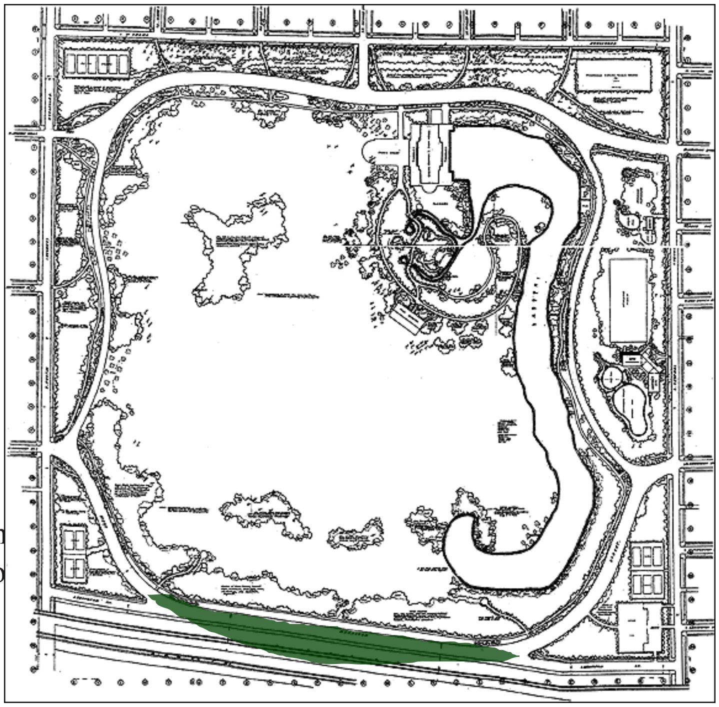
Three distinct ecotypes were recognzed in the Trinity Lakes Park project- *bottomland forest, riparian and urban forest*. It is important to analyze proposed plant compositionsand the species interactions between these plants and animals. The proposed project emphasizes the significance of stormwater management through constructed wetlands, riparian buffers and new forests. Silver Lake Park draws similarities in the urban ecosystem composition. These ecosystems continue to be fragmented along the banks of the Zumbro River and Silver Lake Park.

Trinity Lakes Park integrates three ecosystems capable of withstanding future floods around Dallas, Texas. The following design detail illustrates how each of the three ecosystems are tightly linked to form a cohesive landscape. Silver Lake Park, although at a much smaller scale, has select low areas that are seasonally flooded. A wetland restoration is proposed around the several islands where water tends to have slower currents. The two projects have a strong focus on ecological corridors in the suburbs of an urban city.



COLUMBUS PARK: 1920 - Present

Chicago, Illinois W. Adams Street, S. Central Avenue, Eisenhower Expressway, and S. Austin Boulevard



Columbus Park was designed by early 20th century landscape architect, Jens Jensen, to develop an urban park that idealized the midwestern prairie. It is a 144 acre park situated 7 miles from downtown Chicago. Jensen's design intent was to introduce the country wilderness into an urban environment.

Jensen designed a series of berms reminiscent of glacial ridge encircling the flat interior part of the park. A prairie river flows from two brooks in the middle of the park. "Two natural-looking waterfalls, with ledges of stratified stonework, represent the source of the river" (Chicago Parks District, 2010).

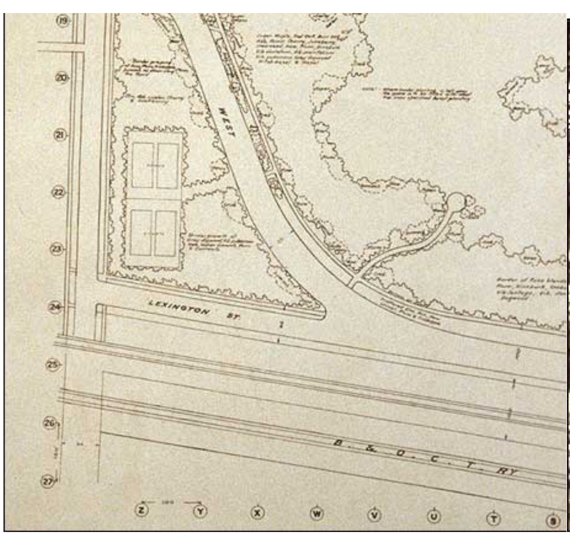
Columbus Park was an initial landscape that emphasized the planting of regional trees, shrubs and herbaceous perennials. It survived over seventy-two years before the Chicago Park District had to renovate the 'Prairie River' and brooks. A contemporary landscape's longevity is now susceptible to many negative ecological pulses caused by humans. Jens Jensen was able to captilize on the ecological processes that was site specific to the historic Chicago landscape.

In 1953, nine acres of the park's southern boundary were cleared for the Eisenhower Expressway. Columbus Park was able to adapt to this large scale biotic disturbance. It is an urban park confined by networks of infrastructure that prevent any future expansion. Jensen incorporated long-term planning into Columbus Park by setting aside over 150 acres prior to urban development.

COLUMBUS PARK:
Chicago, Illinois

"Jensen included programming elements emulating nature with Columbus Park. Broad prairie-like meadows provide a golf course and ball fields. He designed an outdoor theatre, known as the "player's green," for plays and other performances. In the children's playground area, Jensen included his favorite feature, the council ring, a circular stone bench for storytelling and campfires" (Chicago Park District, 2010). Silver Lake has Giant Canadian geese as its cultural identity. An ecological balance between Giant Canadian geese and recreation is currently struggling with Silver Lake Park. The mixed attitudes toward the excessive geese populations have discouraged many people from enjoying recreation at Silver Lake Park. Active and passive recreation is an essential component for Silver Lake Park, which has its strengths and weaknesses.

Jens Jensen's plant selection connected with his overall goal of incorporating light into spaces. He made the changing seasonal impact of light a priority in his design. Specifically, Jensen surrounded a large, open meadow with forests, so people were able to witness the summer and winter solstices. Similarly, Silver Lake Park is surrounded by both randomly scattered deciduous trees along with select riparian areas. The 38 acre Silver Lake has wide stretches of open water, which site users can appreciate its contrast with the landscape. Local neighbors do not have large green spaces they are able to enjoy and had Columbus Park serving this need. Silver Lake Park needs a stronger "sense of place" that engages people to maintain the urban park as people have with Columbus Park.



HISTORICAL CONTEXT

NARRATIVE:

Silver Lake has historical significance to Rochester, MN. The Rochester Park Board in the early thirties planned Silver Lake Park a decade before the final construction of the power plant. Its existence relied heavily on the growing energy demands of Rochester's earlier inhabitants. The excavation of Silver Lake and dam construction were human modifications that altered an indigenous landscape not capable of drastic changes. The regional Zumbro Watershed adjusted to Silver Lake; however, now provides an alternative landscape with plants manipulated on their placement throughout a majority of the park. Humans have accelerated Silver Lake's ecological resiliency.

Ecologically resilient landscapes experience dynamic cycles, which are detrimental to their long-term health. Rochester, MN fell victim to a massive 1893 tornado and a devestating 1978 flood. These natural occurences shape a landscape's ability to heal itself. Specifically, a flood during the summer can decimate certain plant species not capable of enduring anaerobic soil conditions ranging from one to seven days. Plant communities undergo ecological succession influenced by both biotic and abiotic factors. Rochester's pre-settlement vegetation was highly dependent on abiotic or environmental factors such as droughts, floods or disease epidemics to catalyze an ecological succession. The landscape is now strongly influenced by human actions. Proposed landscapes are only capable of accounting for short-term planning due to environmental variability. Silver Lake has mixed generations of plant species. Existing eighty + year old silver maples may have been planted back in the "dirty thirties" to help alleviate soil erosion due to extensive drought conditions. Traditional planning practices had incorporated immediate human needs into their planning.

HISTORICAL CONTEXT

NARRATIVE:

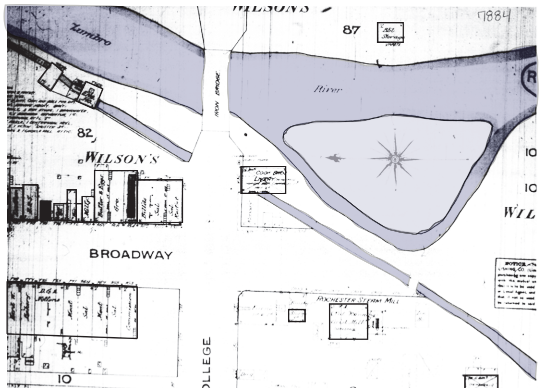
Water has historically been treated as a replenishable commodity rather than a fragile resource. The East Pioneer and Northrup neighborhoods were built within a quarter mile of either the Zumbro River or adjacent streams. The Silver Lake power plant has discharged warm water into Silver Lake for the past half century. In return, the lake has rarely frozen over and made Silver Lake a major fall and winter migratory location for Giant Canadian geese. Giant Canadian geese have resulted in social benefits, but have degraded water quality due to an excess amount of fecal coliform bacteria. A perception of Silver Lake's water quality has changed from desirable for recreational activities in the thirties and fourties to a current negative public perception. Giant Canadian geese served as a catalyst in the fifties and sixties with its population growing at an exponential rate for several decades.

Our design responsibilities as landscape architects, planners and environmental designers are to continue to counteract the negative consequences of traditional and contemporary planning practices. Silver Lake Park has clearly illustrated it has experienced significant ecological changes that have developed new environmental problems. Human modifications based on their immediate needs such as concrete or asphalt roadways are satisfied at the expense of long-term survival of urban ecosystems. A renewed focus on ecological services and their effects on our everyday activities is one of the limited long-term solutions for urban parks. A landscape's ecological resilience has some constraints with human modifications accelerating irreversible changes. Silver Lake's history has been able to endure changes for the past century, but will it for another fifty years?

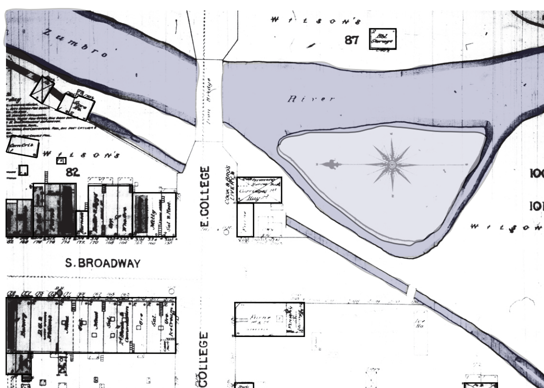
HISTORICAL CONTEXT

SILVER LAKE PARK

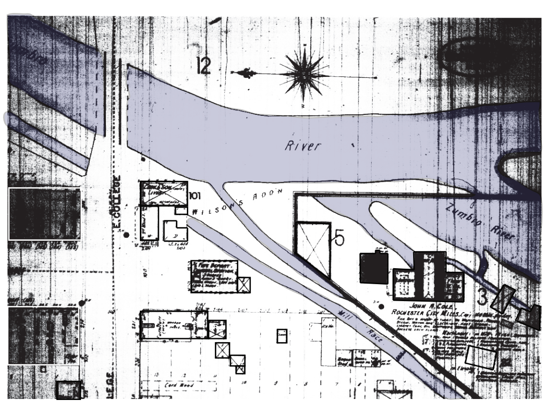
Sanborn Fire Insurance Maps: 1884 to 1909



July 1884: (Sanborn 1981)



June 1890: (Sanborn 1981)



June 1899: (Sanborn 1981)

1880

1884

1890

1900

August 21, 1883: Tornado

"Two F3 and a F5 Tornado destroyed roughly a third of Rochester. It killed 37 people along with injuring 200+ others" (NOAA, 2008). The tornados hit Rochester directly, which leveled 135 buildings and left 200 houses damaged. It cost the city "$700,000 in loss," which is valued at $21.9 million dollars in 2007.

Saint Mary's Hospital was initiated by Dr. William Mayo and Sister Mary Alfred Moes due to the desparate need of an adequate health system in southeast Minnesota. Saint Mary's Hospital eventually led to the formation of the world-renowned Mayo Clinic.

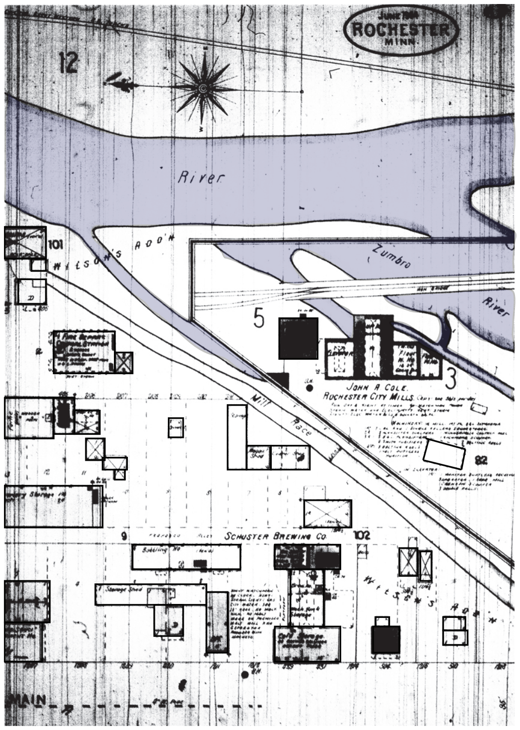
Residential section from Cole's Rochester City Mills

HISTORICAL CONTEXT

SILVER LAKE PARK

Sanborn Fire Insurance Maps: 1900-1910

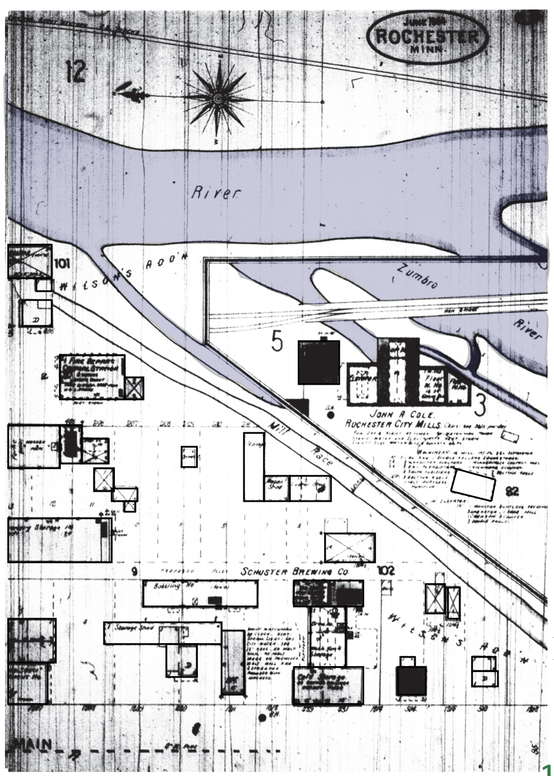
1900



June 1904: (Sanborn 1981)

1904

1905



April 1909: (Sanborn 1981)

1909

1910

“Rochester had grown nearly 15 percent from 1900 to 1910”, which increased the water and energy needs of residents. (RPU 2006).

HISTORICAL CONTEXT

SILVER LAKE PARK

Sanborn Fire Insurance Maps: 1909 to 1928

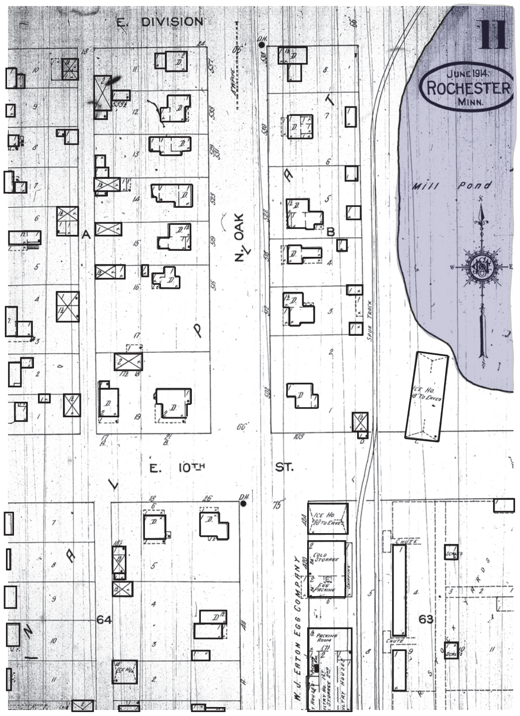
1910

1914

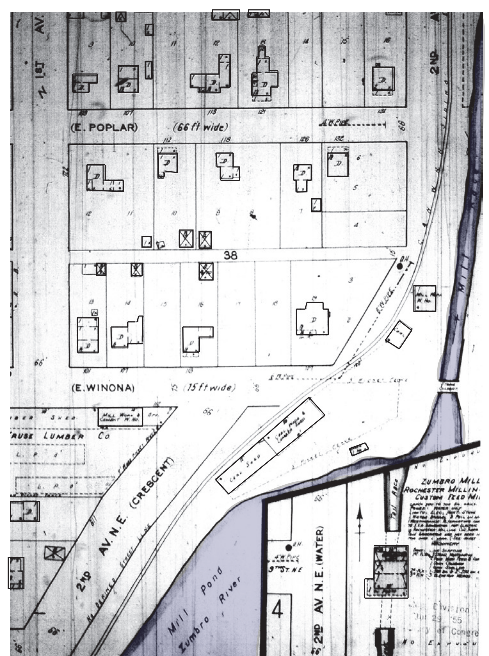
1920

1928

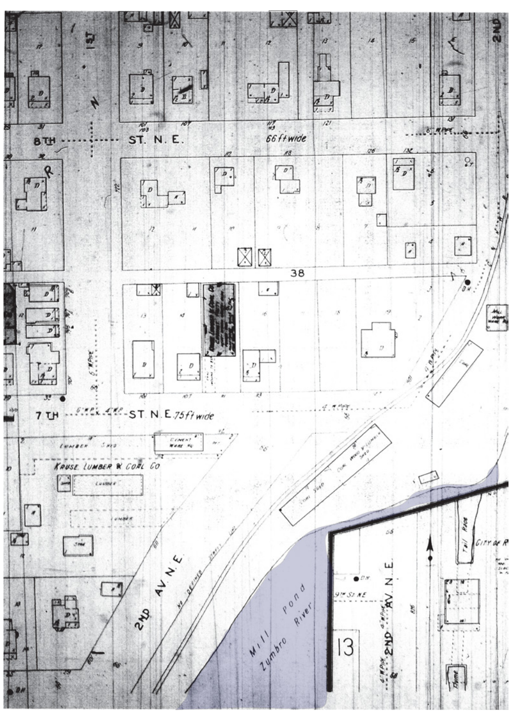
1930



June 1914: (Sanborn 1981)



Oct. 1920: (Sanborn 1981)

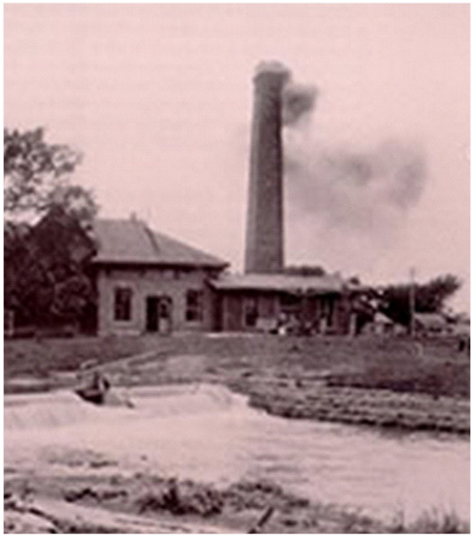


June 1928: (Sanborn 1981)

HISTORICAL CONTEXT

SILVER LAKE POWER PLANT:

Rochester, Minnesota



INCREASING DEMAND:

"City growth by 1915 indicated the water and electric service would face enormous demands. 1910 to 1920 was the explosion in growth decade; the city grew from 7,844 to 13,722, a 75 percent growth rate! As a result, city leaders were looking at water and electric service changes for Rochester. The Utility Board, formed in 1904, would study building a new and more reliable light plant in 1915 after the Third Street Southwest plant burned on October 31, 1915"

1930

SILVER LAKE PARK:

"Park Board developed plans for the Silver Lake Park in the 1930s, the Utility Board requested that some of that property be used for a new generating plant. Laborers toiled to dig what became Silver Lake in this circa 1936 photo. This public work project was thecenterpiece of the new park in the June 1937 dedication" (RPU, 2006).

1940

SILVER LAKE PLANT:

"Construction began in 1947 with a groundbreaking ceremony. The new Silver Lake Plant went on-line in April of 1949. The 7500-kW unit was powered by a 90,000 lb./hour steam boiler and necessary equipment" (RPU, 2006).

1950

HISTORIC 1978 FLOOD:

July 5 - 6, 1978

The historic 1978 flood contained a heavy "band of 6 to 7 inches just south and east of the Rochester area. The National Weather Service (NWS) gage at Rochester International Airport measured 4.99" in 3 hours (between 5:53 p.m. and 8:53 p.m.) on July 5th with precipitation ending around 1:50 a.m. on July 6th. The total rainfall at Rochester International Airport was 6.74 inches. The 4-inch or more rainfall band was about 12-15 miles wide and 74 miles long and covered 700 square miles. The South Fork Zumbro River and it's tributaries (Bear Creek, Silver Creek, Cascade Creek) went into flood through Rochester causing extensive damage" (NOAA, 2009).

"Rivers started rising during the evening and continued at a foot per hour during the night. The July 6th crest (at 10 AM) at the Rochester river gage (on the south fork of the Zumbro River) established an all-time record of 23.36 feet (flood stage 12 feet) and 30,500 cubic feet per second. This flood was considered Rochester's worst natural disaster in almost 100 years and the worst flood in the city's history. One fourth of the city, mainly south and northeast sections were inundated by turbulent flood water 6 feet deep or more" (NOAA, 2009).

HISTORICAL CONTEXT

SOUTH FORK ZUMBRO RIVER FLOOD PROJECT:
August 1987 through August 1995

The South Fork Zumbro River flood mitigation project was designed and constructed in partnership between the U.S. Army Corps of Engineers and the Natural Resources Conservation Service.

"The Corps of Engineers' project consisted of channel modifications, including widening and deepening the existing channel and adding riprap, concrete and steel sheet-pile bank protection on the South Fork Zumbro River and two tributaries: Cascade Creek and Bear Creek. Principal features of the Corps' project included 5.7 miles of riprap-lined channel, 0.7 mile of architecturally treated concrete channel, 0.5 mile of dredged channel, 3 drop structures, 1.3 miles of levees, non-structural features and recreation features such as hiking and bicycling trails" (U.S. Army Corps, 2008).

"The Natural Resources Conservation Service project consisted of a system of seven upstream reservoirs on Bear Creek, Silver Creek and Cascade Creek to reduce upstream runoff. Other features of the Natural Resources Conservation Service project included upstream bank stabilization and creation of a 118-acre lake and county park. Together, the two projects protect the city of Rochester against a flood with approximately a 0.5 percent probability of occurrence annually. A flood of this probability is sometimes referred to as a 200-year flow frequency or 200-year flood" (U.S. Army Corps, 2008).

1980

1982: City residents authorize a 1% sales tax. Legislature approved sales tax in 1983.

1986: Section 401(a) of the Water Resources Development Act of 1986, Public Law 99-662, authorized the Corps of Engineers project for construction.

Aug 1987: Local Cooperation Agreement executed

Sept 1987: First construction contract awarded

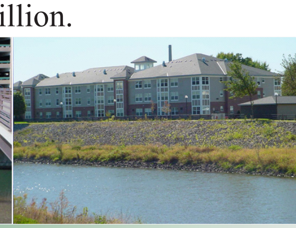
1990

1992: Corps' project was reauthorized in the Water Resources Development Act of 1992, Public Law 102-580. $25 million collected in 1983 Tax.

1995: Aug Construction completed

Federal Cost: $67,908,000
Non-federal Cost: $24,818,000
Total Estimated Cost: $92,726,000
NRCS project had a total cost of approximately $14 million.






2000

HISTORICAL CONTEXT

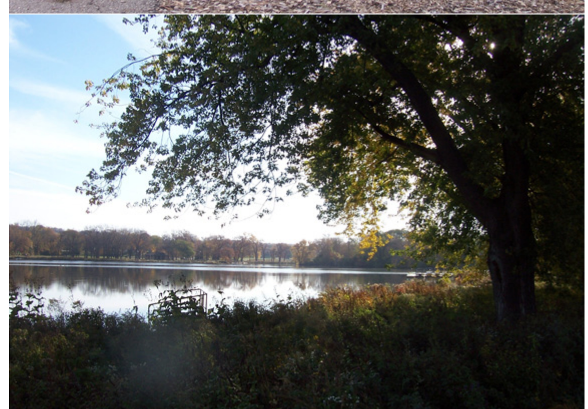
SILVER LAKE BUFFER PROJECT:
April 2007 to Present

The project consists of 7,500 linear feet of vegetated buffers to control polllution loads into Silver Lake and Zumbro River. It was funded by $550,000 in tax dollars and had Prairie Restorations as a major consultant. The project service area includes approximately 47.8 acres immediately adjacent to Silver Lake with 6.2 acres being vegetated buffers. A programmatic goal of the buffer project is to discourage some of the Giant Canadian geese population from migrating to Silver Lake.

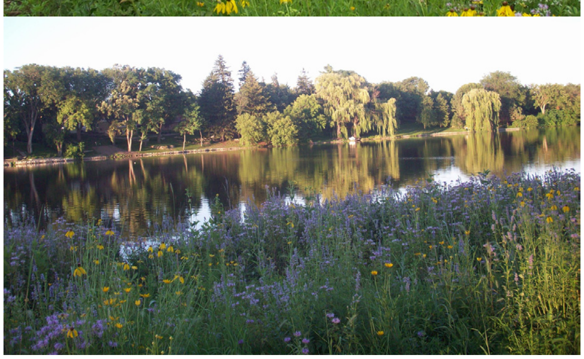
Silver Lake has a "fall peak population of 40,000 migratory Giant Canadian Geese," which increases fecal coliform bacteria loading. Fecal coliform bacteria concentrations have made Silver Lake an "Impaired Waterway by the Minnesota Pollution Control Agency (MPCA) and US Environmental Protection Agency (USEPA)". On April 5, 2006, USEPA approved the final Total Daily Maximum Load study for fecal coliform for the Lower Mississippi River Basin (City of Rochester, 2007).

Several areas in the Silver Lake buffer project were not analyzed based on site specific conditions. The right image illustrates deciduous trees planted 6 feet apart in which these trees should have a minimum of 35 feet apart. Second, full sun or 6-8 hours of direct sun perennials were planted underneath mature trees. Mature trees provide dense shade, which results in powdery mildew. Powdery mildew can spread quickly across plant compositions (3rd, right image).

Poor Long-term Planning



Successful Buffer Components:



HISTORICAL CONTEXT

GIANT CANADIAN GEESE:
Migratory, Molt & Resident Geese

Migratory Geese

Migratory geese are in Rochester in September through February. Migratory geese in Rochester number between 20,000 to 35,000 at their peak in November of each year. That range has remained fairly constant since 1970, but was considerably lower prior to 1970.

The highest peak was 40,000 in November of 2005, but the peak numbers for 2,000 through 2004 were considerably lower. Migratory geese are federally protected under the Migratory Bird Treaty Act.

"Molt" Geese

Molt migrant geese are young adults as pictured in the top left of the right image. According to the Minnesota DNR, "approximately 3,000 young adult 'molt migrants' are in Rochester during the summer."

Resident Geese

There are between "1,000 to 2,000 resident geese that reside in Rochester on a year round basis" (Minnesota DNR, 2010). This number has been increasing between 10% to 20% per year, despite recent changes in hunting regulations to permit an earlier hunting season in SE Minnesota. At the current rate of annual growth, the resident goose flock may double every 6 to 7 years if steps are not taken. Resident geese nest in the undisturbed vegetated island during the spring.

ACADEMIC:

Insightful Theoretical Premise

The theoretical premise serves as a foundation for the entire design thesis. It provides a design problem through research in order to solve a design problem relevant to landscape architecture.

Thorough Thesis Proposal

A design thesis is successful with the development of a well thought-out thesis proposal. Invaluable knowledge learned in the thesis proposal will assist in the design phase of Silver Lake Park.

Design Suitable for Theoretical Premise

The final design needs to provide solutions for questions raised from the Theoretical Premise. A design should be site-specific and relevent to other dynamic and engaging urban parks.

Long-Term Design Solution

A design solution that embraces ecologically resilient landscapes that catalyze urban park development. The landscape will expand on Ian McHarg's environmental planning strategies discussed in *Design with Nature*.

Research Documentation

Meaningful documentation of the theoretical premise and unifying idea will challenge contemporary landscape designs regarding ecologically resilient landscapes. Ecological design principles which emphasize biodiversity will be provided for prospective landscape architecture students.

Challenging Schedule

A schedule should challenge and utilize time management skills to achieve project deadlines. It needs to encourage a throrough completion and understanding of all proposed design elements.

PROFESSIONAL:

Consistent Documentation

The final design should consist of a well-developed thesis project, documented, displayed, presented and published as it would at a professional landscape architecture firm.

Profession Suitability.

The professional aspect can be defined or characterized by a final product that is suitable for presenting to outside professionals in landscape architecture. A design thesis is the culmination of 5 years of design education one should be proud of in the past, present and future.

PERSONAL:

Professional Challenge

I believe it is necessary to grow as a designer from the design thesis. It's content should serve as a strong basis for individuals wanting to challenge the status quo in specific areas of the design profession.

Academic Challenge

My professional career will utilize bachelor's degrees in Landscape Architecture and Horticulture to make my mark on the profession by following strong ideals. Similarly, my design thesis should leave my mark at North Dakota State University as I pursue a career as a licensed landscape architect. I consider my design thesis as a synthesis of ideas that have been expanding through my past 6 years of college education.

SITE ANALYSIS

NARRATIVE:

Silver Lake Park has layers of information to understand ranging from its site history, land use, vegetation, vehicular patterns, hydrology, geology and soil development and climate. These layers provide professional designers insight into the environmental variability that affects a urban park's short and long-term viability.

Site history illustrates human modifications and their intentions over a long period. Specific design practices can be associated with either a specific decade or a public's perception of an environment. Site history provides explanations for current patterns and processes partly tied to past events. Silver Lake most likely would not have existed without the expanded reservoir prior to the 1949 power plant completion. Site history relates with our past land uses.

Land use is the overall dynamic network of an urban city. The concentrations of industrial, commercial and residential properties changes with our economy. Silver Lake is at the convergence of early 20th century industrial and residential properties. Silver Lake Park has a strong relationship between industrial and residential. An industrial power plant uses Silver Lake to discharge warm water from energy development while residential has benefits of an urban green space. Green spaces contain an underutilized necessity to urban city vegetation.

Vegetation can be synthesized as urban forests and riparian buffers. Urban forests are manipulated by design practices to establish continuity through boulevard plantings. Trees have a multitude of benefits that affect temperature, wind and moisture regimes. Vegetation confronts some of the adverse effects of urban development such as urban runoff and warming. Trees filter sediments while reducing the "urban heat island" effect. The urban heat island effect warms downtown urban spaces due to excessive impervious surfaces reflecting solar radiation. Landscape connectivity is evident in very limited areas of urban cities due to habitat fragementations and human modifications. Riparian buffers contain the biological complexities of urban ecosystems.

SITE ANALYSIS

NARRATIVE:

plant dispersal and wildlife corridors are essential components to the ecological processes affecting human lives. Plants can demonstrate their adaptability to local soil compositions, moisture gradients and winds. Our designs can strengthen by understanding the interactions between plants, animals and humans within an urban ecosystem. Ecological corridors are disconnected due to vehicular roads.

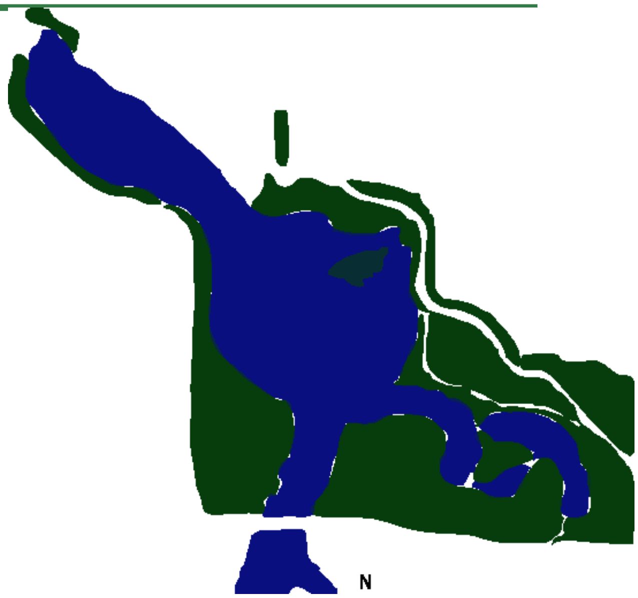
Vehicular roads break existing ecosystems down into a mosaic of fragmented corridors. Vehicles dominate roadways while limiting pedestrian safety. Roads are currently the main transportantion route to Silver Lake Park. Greenway connections are possible to minimize the disconnect between adjacent neighborhoods and Silver Lake Park. Hydrology is a design element affecting all aspects of our landscapes.

Regional hydrology needs to be well understood by designers in order to design either upstream or downstream without drastically altering another landscape. Long-term wet and dry cycles provide design challenges that can be addressed through understanding a regional hydrologic cycle. Geology and soil development are formed by their interactions with the environment.

Geological processes are the results of thousands of years of environmental interactions. The geological substrates such as exposed limestone can be integrated into the design. Soil development affects living plants and has specific constraints that shape the existing landscape. Climate connects all design elements through environmental variability.

Climate accelerates adaptive cycles over a long period of time. A design can be ephemeral with short-sighted planning, but will fail in the long-term due to environmental variability. An extended wet cycle is currently affecting the upper midwest. Seasonal variations are distinct in southeast Minnesota with transition from winter, spring, summer and fall. Climate allows designers to understand the Earth is a dynamic planet and that we must plan our human activities in light of that knowledge.

SITE ANALYSIS

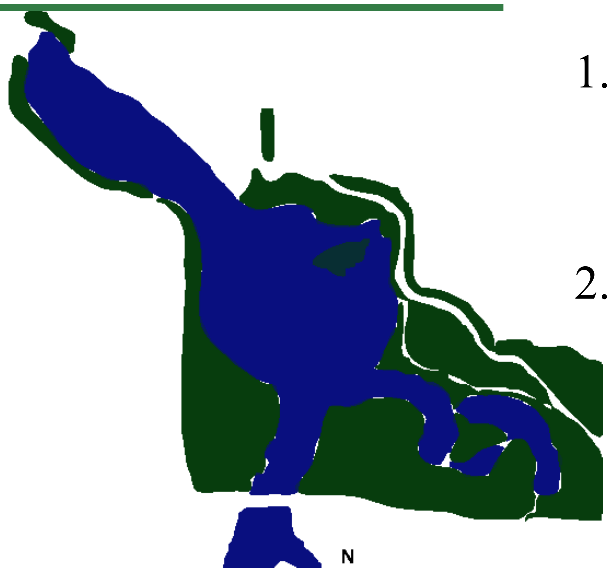


1. Children's playground is centrally located between a parking lot and Silver Lake.

2. South perspective looking towards downtown Rochester. Riparian buffers provide a boundary between land and water.

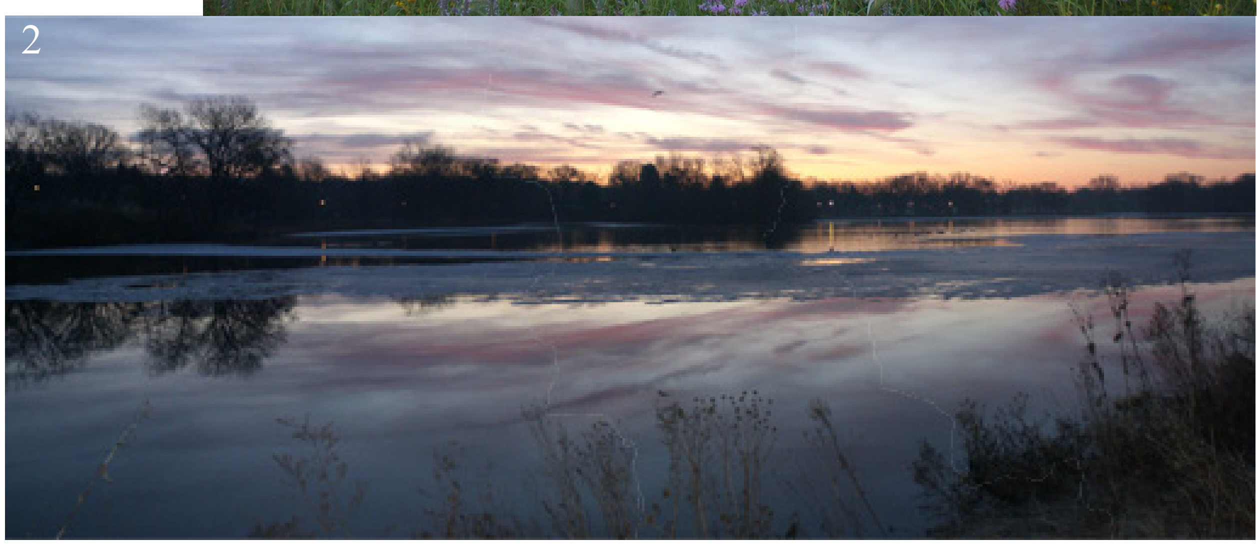
3. Pedestrian & bike trail past mature common hackberries, river birches and silver maples. The park's main parking lot is located east near the Northrup neighborhood. Kentucky bluegrass has been heavily foraged by Giant Canadian geese, which has increased undesirable weeds.

SITE ANALYSIS

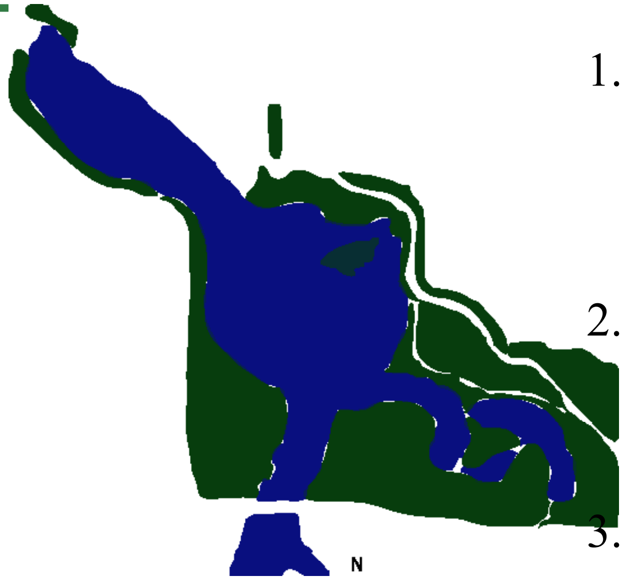


1. Silver Lake buffer project in its third year is in the foreground. The plantings work well here due to direct sun for 6 to 8 hours. Private Residences are located north of Silver Lake.

2. Silver Lake on a cool early March morning. Silver Lake does not freeze over completly due to the power plant. Large ice sheets are flowing to the left downstream towards the dam.



SITE ANALYSIS

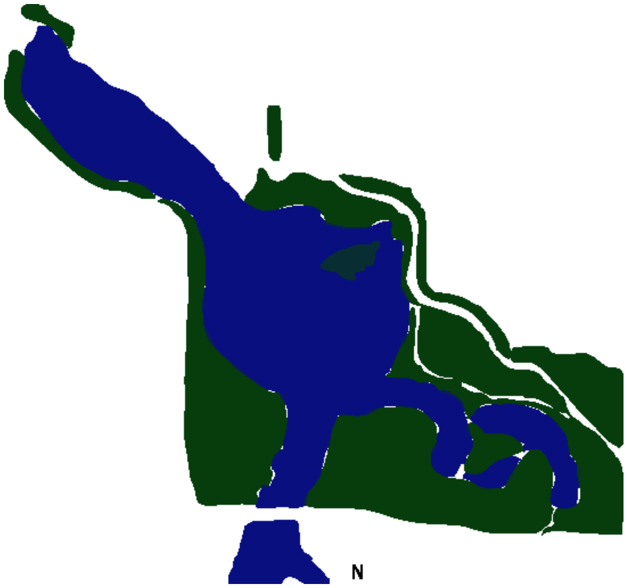


1. The 14th St. N. entrance has ‘Thunderchild’ Crabapples and Norway Maples planted in a boulevard. It serves as a secondary entrance since the 7th St. N and West Silver Lake Dr. are more desirable routes for area residents.

2. East Silver Lake Dr. has no distinct boundary between pedestrians and vehicles. Speeding traffic can be an issue here as noticed on a July 15th site visit.

3. A beautiful late fall view towards downtown Rochester and the Silver Lake power plant. It is taken from a memorial bench that contained no vegetation around it and created an exposed feeling.

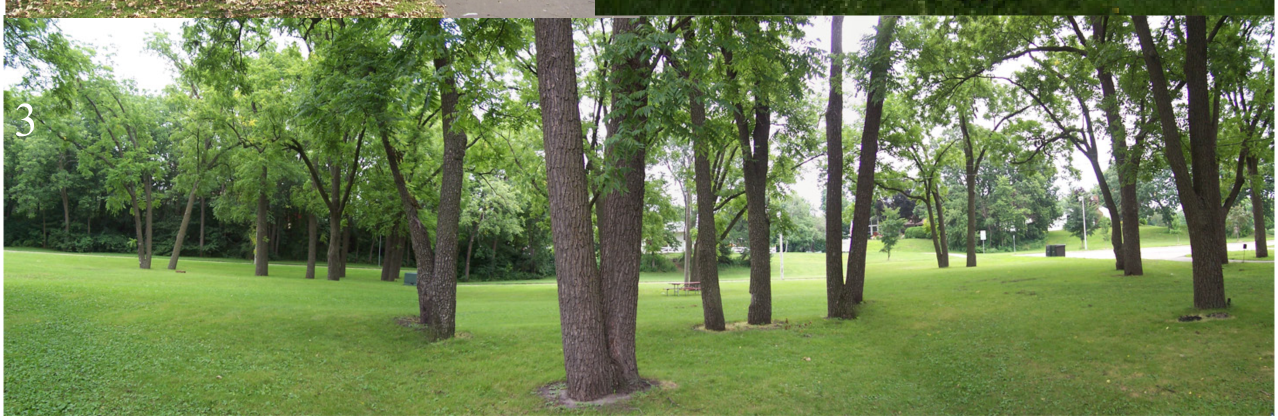
SITE ANALYSIS



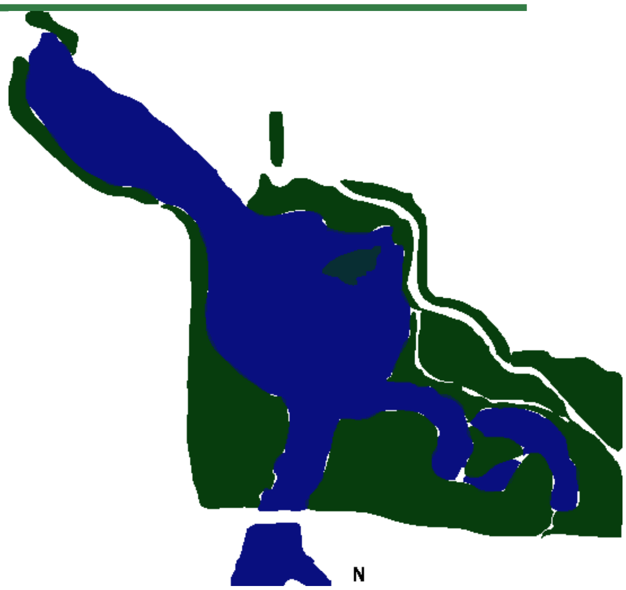
1. A limestone picnic shelter is the only building infrastructure on Silver Lake Park. The picture is a north perspective with Black Walnuts in the background.

2. An east perspective shows Grace Lutheran Church in the background (right) along with a baseball diamond. A three year old vegetated buffer is in between blooming periods in mid August.

3. A Black Walnut grove may have been an indigenous stand due to the random distribution of trees. Younger trees were possibly removed to allow this specific area to appear picturesque.



SITE ANALYSIS

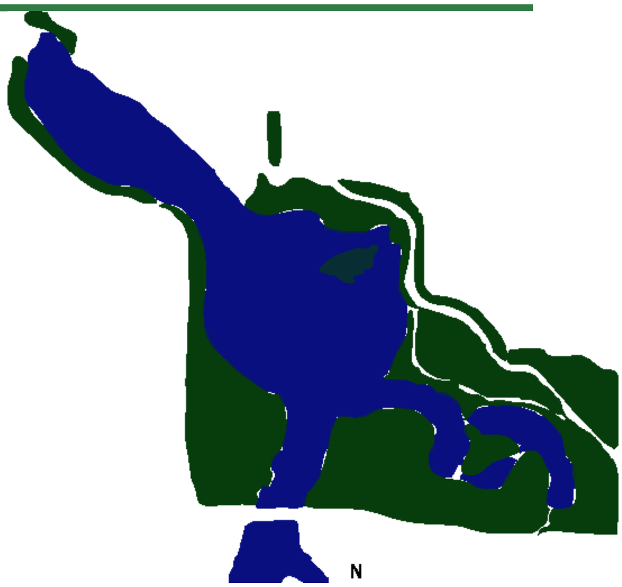


1. A casted limestone bridge is one of three existing bridges connecting people to several vegetated islands. The islands contained some scenic views of Silve Lake looking west, north and south.

2. A west perspective shows the more populated portion of Silver Lake. It was one of the feeding lots for Giant Canadian geese until it was discontinued in 2007 prior to the buffer project.

Established forb communities create a mosaic of colors and textures for walkers, runners or bikers. The buffer changes with the seasons, which ensures a weekly variation.

SITE ANALYSIS



1. A detail of the cast limestone bridge overlooking a vegetated island consisting of Colorado spruces, Japanese tree lilacs, oaks and deciduous shrubs.

2. Sixty plus year old bur oaks cast shade on vegetated buffers below. The trees help trap sediments before they can flow into Silver Lake

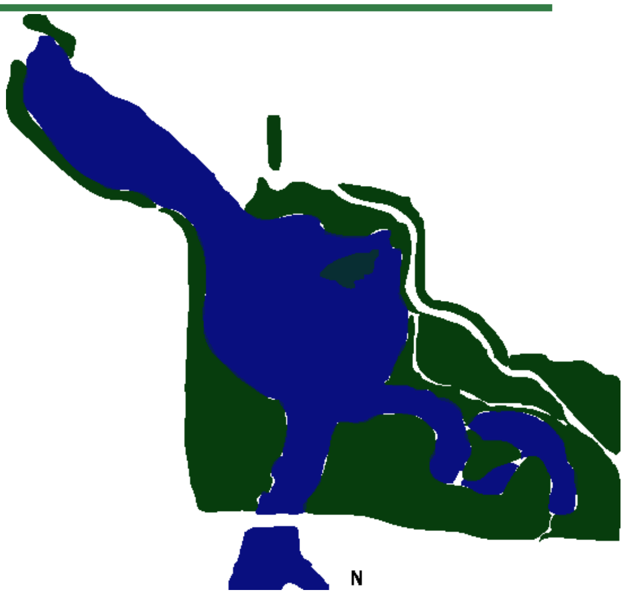
3. A northeast perspective from one of the islands shows a drastic change in landscapes between vegetated areas and low vegetation.


1


2


3

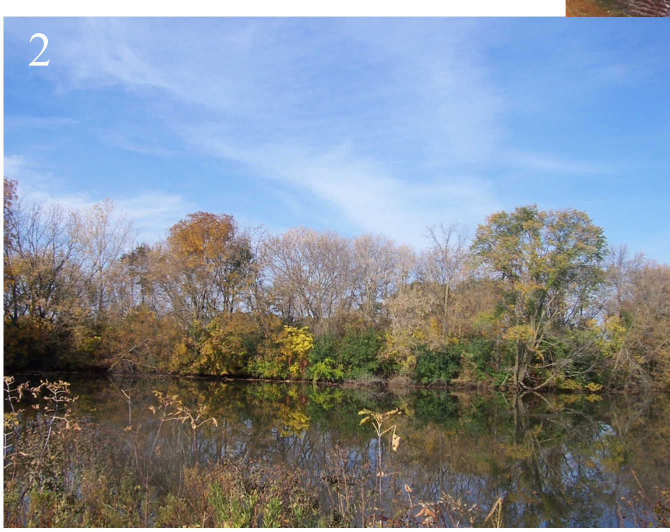
SITE ANALYSIS



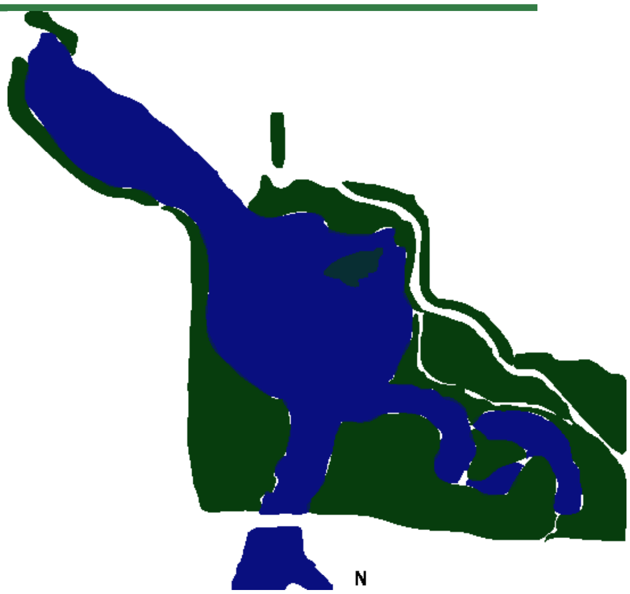
1. A riparian buffer is on the southeast corner of Silver Lake Park and is one of several fragmented within a mile radius.

2. Riparian buffer displays its stratified layers in conjunction with early October fall coloration.

3. A cast limestone bridge leads pedestrians to a walking path through some of the riparian buffer towards 7th St. N. A newly planted Common Hackberry is part of the 2007 Silver Lake buffer project.

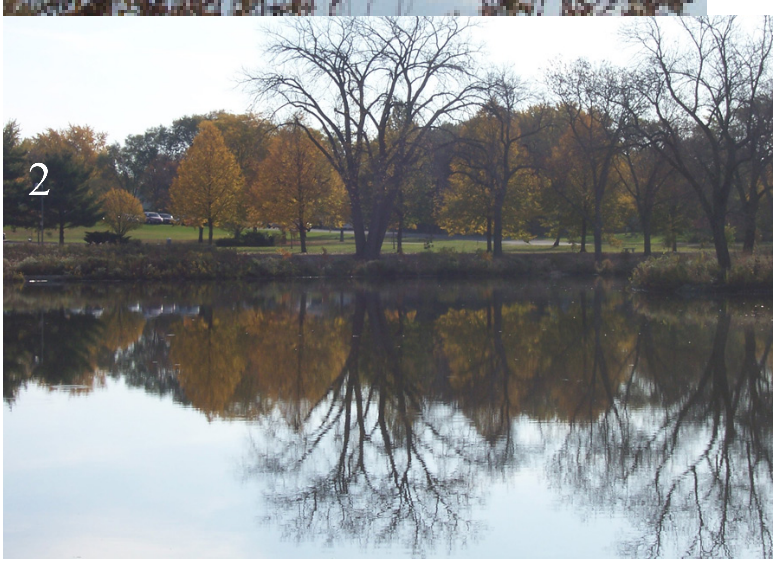


SITE ANALYSIS



1. A east perspective from an island shows Grace Lutheran Church and the adjacent baseball diamond. A three year old vegetated buffer outlines Silver Lake.

2. 'Greenspire' Littleleaf Lindens highlight their golden yellow fall colors along a pedestrian and biking trail. Mature eastern cottonwoods have already lost their leaves on this October 15 site visit. The vegetation reflects in Silver Lake and adds another aesthetic quality to the park.



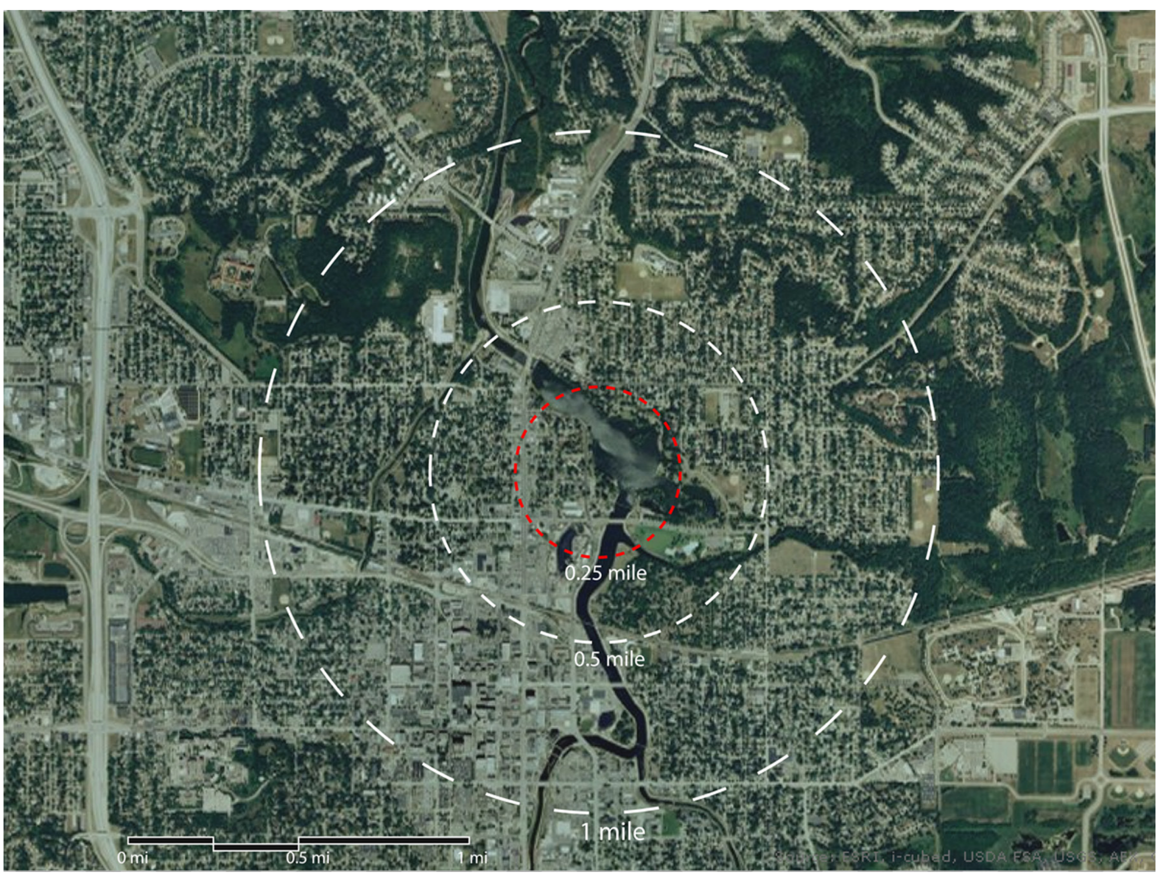
REGIONAL & NEIGHBORHOOD SITE CONNECTIONS

Rochester, MN: Silver Lake Park

Distances for Area Residents

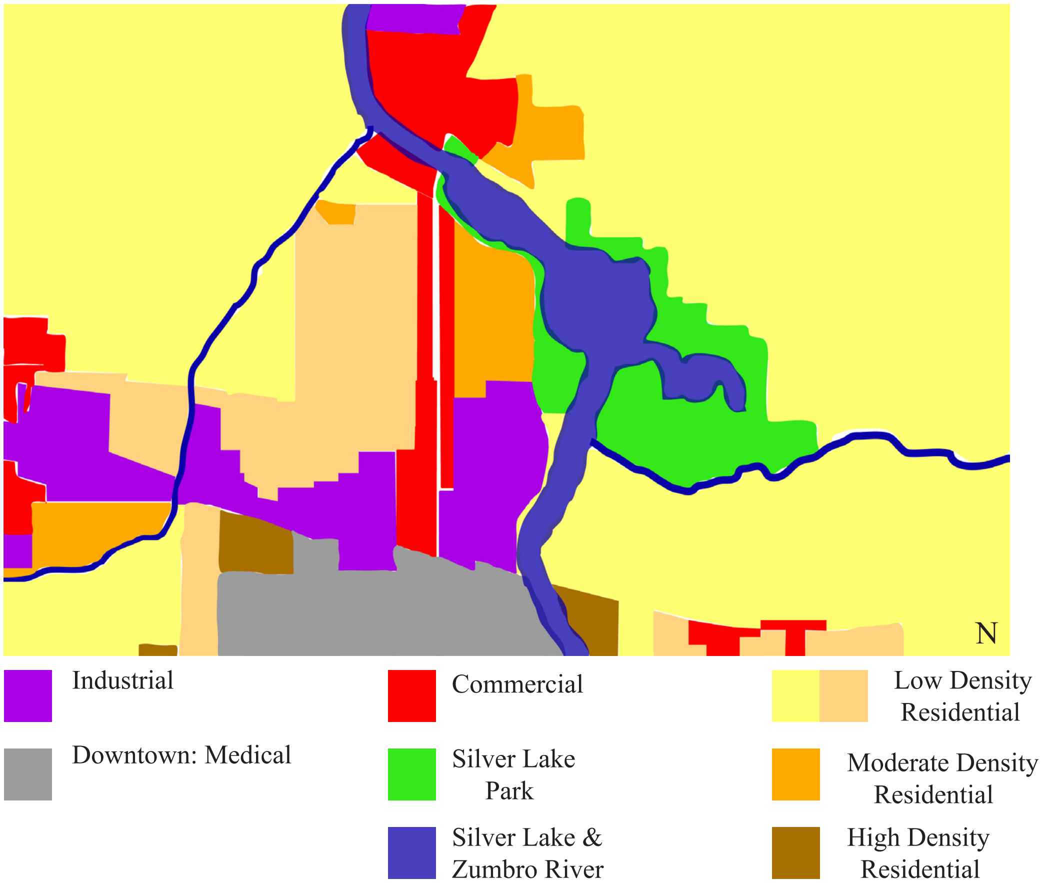
Silver Lake Park has site connections to a majority of older Rochester neighborhood developments. It is conveniently located a mile northwest of an expanding downtown district. All three surrounding neighborhoods are withinimmediate walking distance ranging from a quarter to half mile.

Silver Lake Park has vehicular traffic as the main mode of transporation to and from the park. Greenway connections that place pedestrians first over vehicles is a necessary design element for short and long-term planning objectives for Silver Lake Park.



SITE ANALYSIS

ZONING MAP:



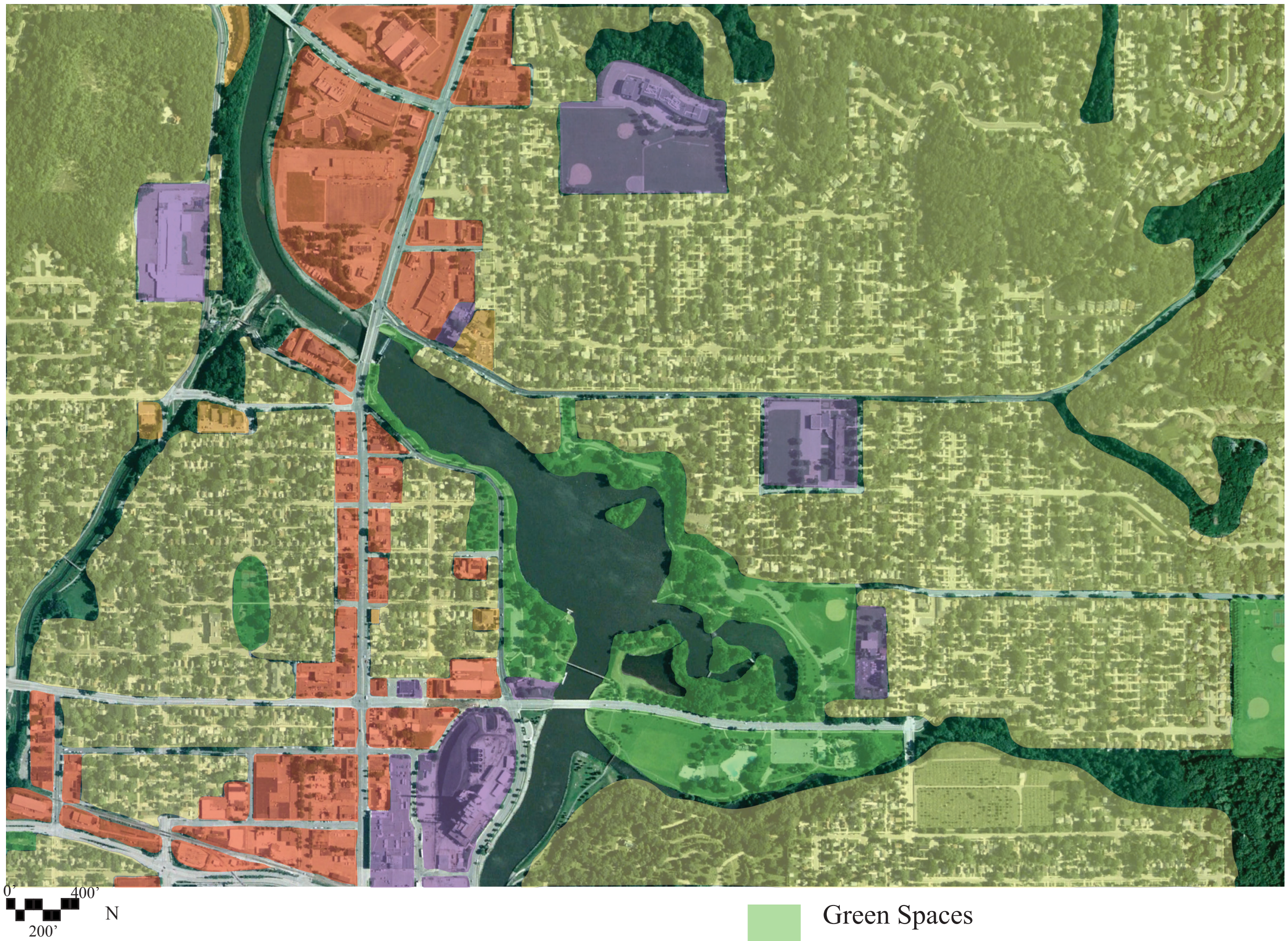


Downtown and medical facilities are growing north to northeast towards Silver Lake Park. An industrial zone where the DM & E railroad and Silver Lake power plant are located controlled downtown Rochester from expanding north. The addition of a University of Minnesota campus in downtown; however, has catalyzed urban renewal north of the industrial zone. University apartments have gained traction over the past year along North Broadway.

Silver Lake has moderate density residential housing in the Northrup neighborhood along with low densityresidential in the East Pioneers and Glendale neighborhoods. The moderate density residential has been degrading over the past decades and has potential for the additions of smaller businesses.

SITE ANALYSIS

ZONING MAP:



Green Spaces

Low Density Residential

Medium Density Residential

Commercial

Industrial

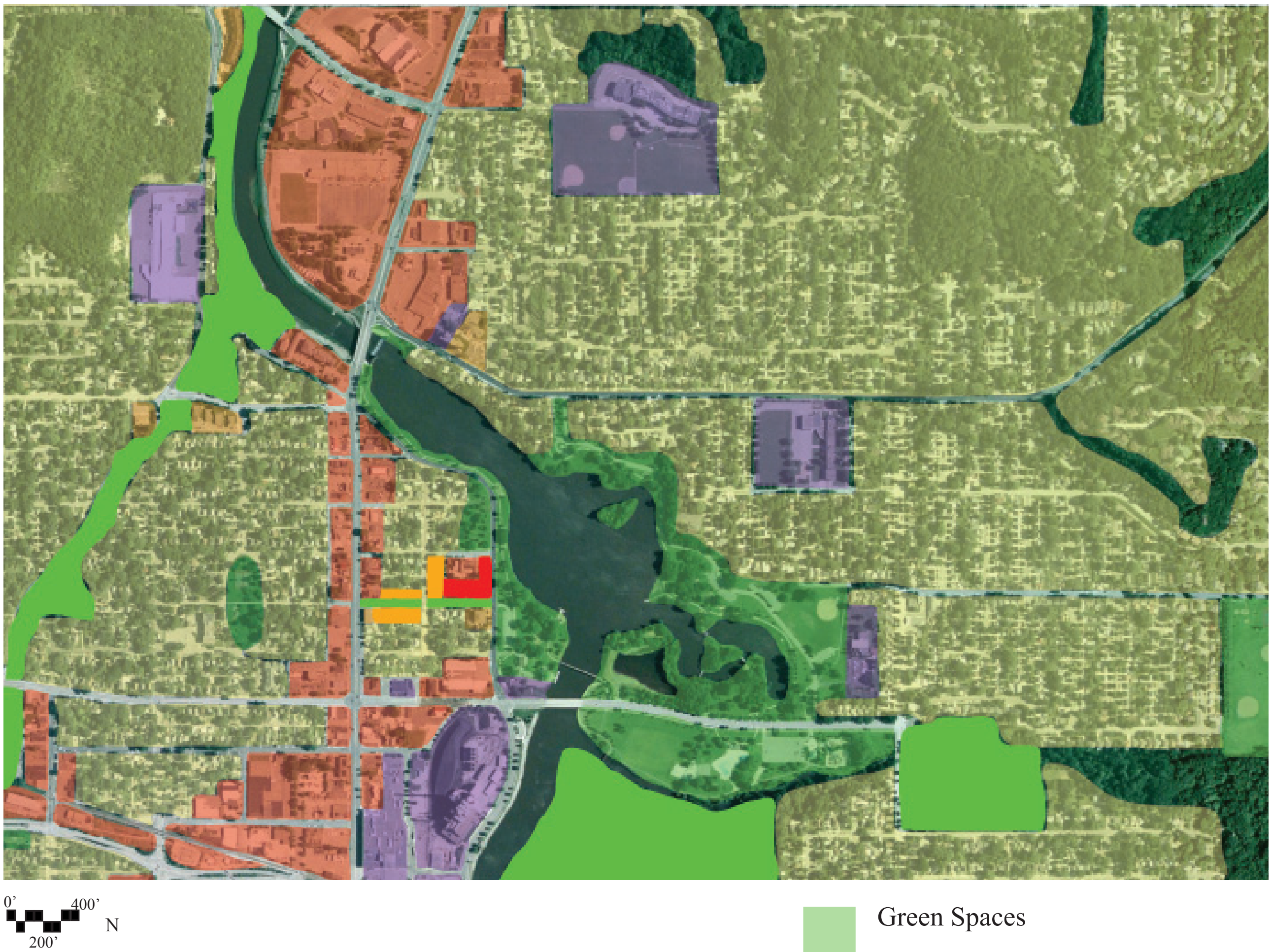
Green networks and ecological corridors need to be zoned as green space to prevent future urban development.

Downtown Rochester is expanding northeast towards Silver Lake with the recent addition of the University of Minnesota campus.

Medium density residential must be a short-term planning goal to accomodate the continued downtown expansion.

SITE ANALYSIS

ZONING MAP:



Green Spaces

Low Density Residential

Medium Density Residential

Commercial

Industrial

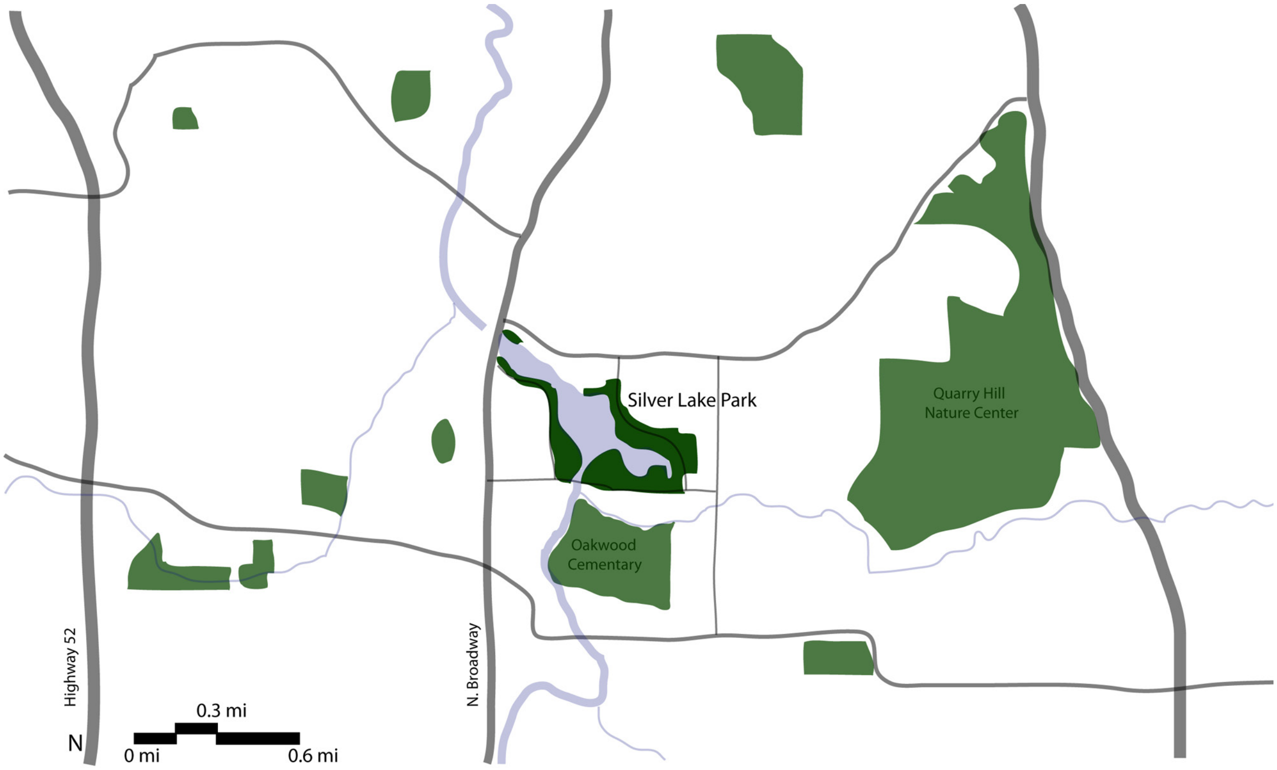
Rezoning of green spaces minimizes future habitat framentation for humans and wildlife.

Urban development of the Northrup neighborhood satisfies long-term planning objectives for downtown growth.

Rochester's park systems are formally unified with a renewed interest in ecological corridors and biodiversity.

SITE ANALYSIS

GREENWAY CONNECTIONS:

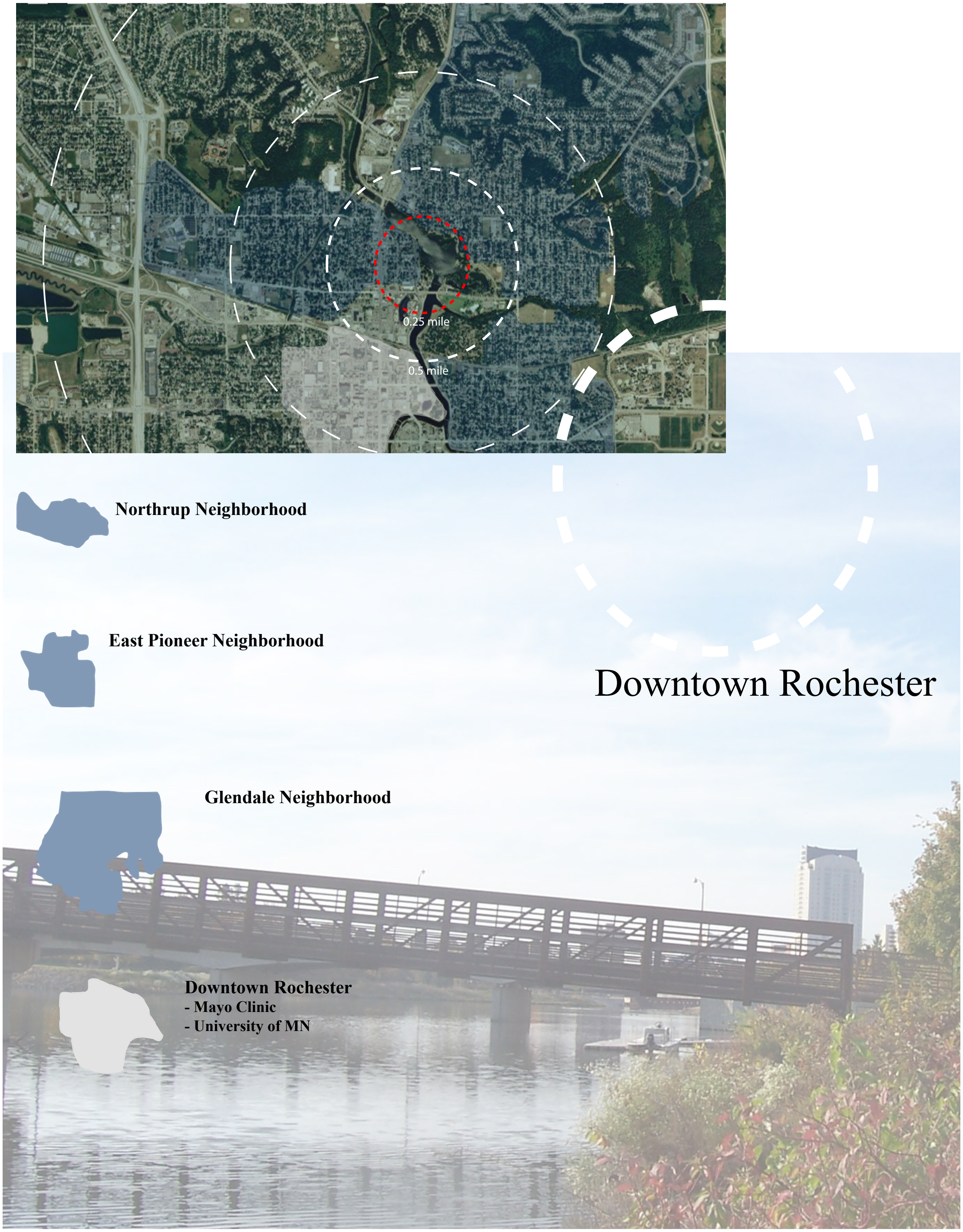


Silver Lake Park is located approximately 1 mile west of Quarry Hill Nature Center. Quarry Hill Nature Center is a 320 acre nature learning center and preserve. Neighbors in the adjacent east Pioneer and Glendale neighborhoods are within a half mile walking distance to either Silver Lake Park and Quarry Hill Nature Center.

Oakwood Cemetery is an 1893 'picturesque' landscape directly south of Silver Lake Park. Silver creek and its riparian buffers create a physical boundary between both of these parks. Oakwood Cemetery has a large variety of pyramidial arborvitaes and other evergreens. Evergreens are formally trained into distinct geometric shapes. Deciduous trees are found in a random spatial orientation throughout Oakwood Cemetery.

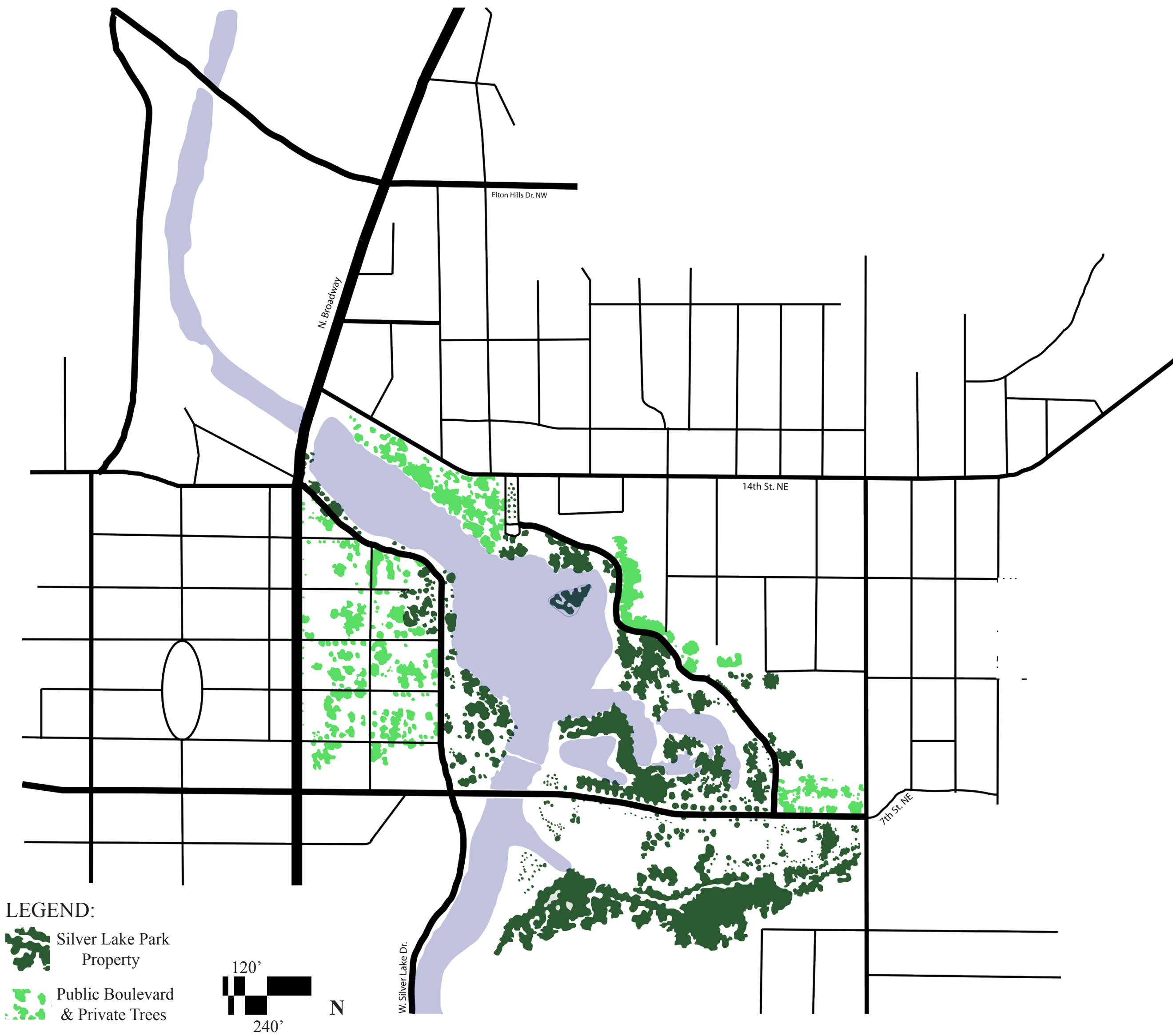
SITE ANALYSIS

NEIGHBORHOOD CONNECTIVITY:



SITE ANALYSIS

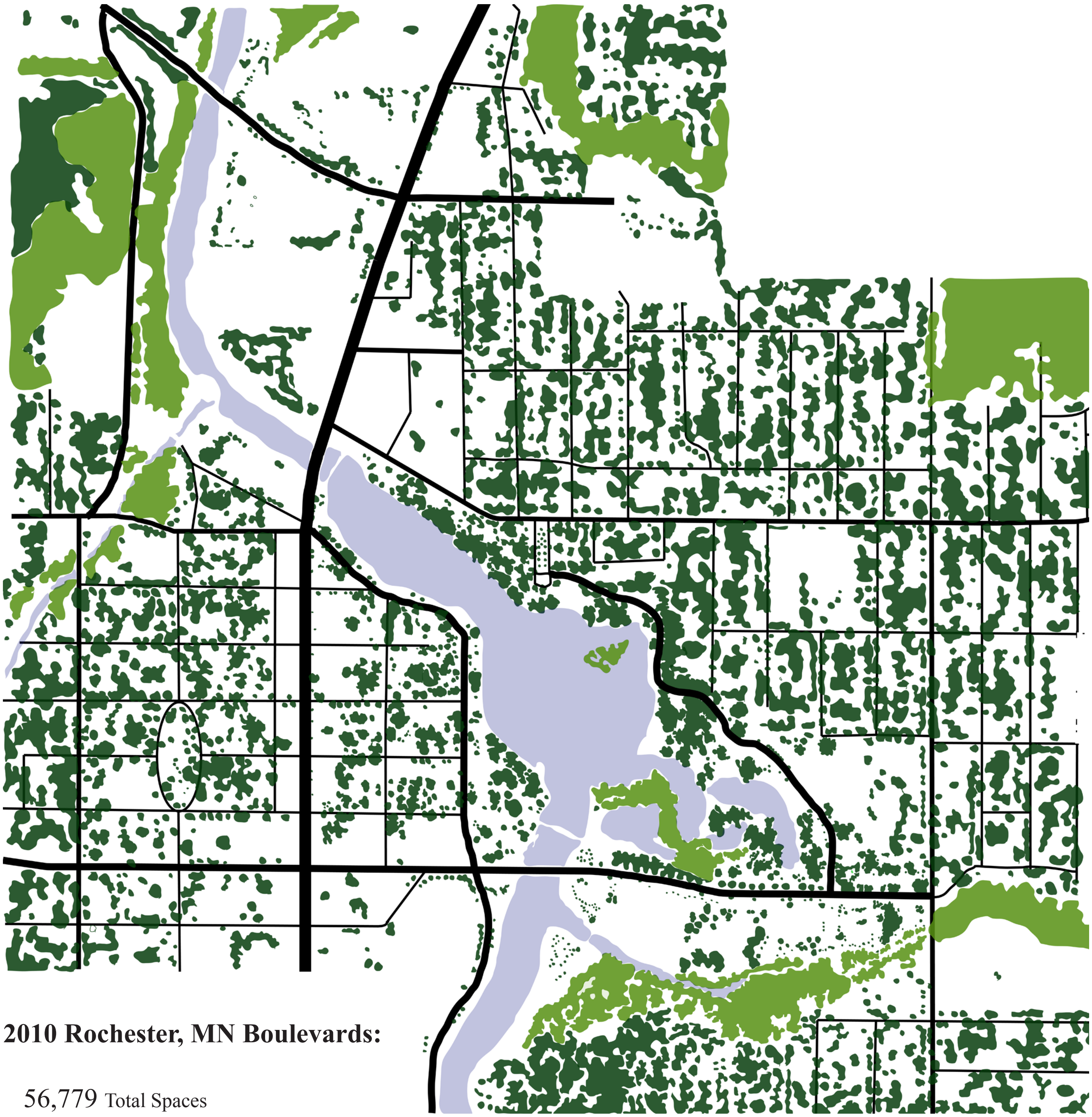
SILVER LAKE PARK VEGTATION:



Silver Lake has a limited plant palette resulting from traditional land management practices. American elms, common hackberries and silver maples are the main deciduous trees evident throughout Silver Lake Park. Kentucky coffee trees and ginkgos have been gaining populatiry along West Silver lake Dr. over the past several years. Green ash is only located in three areas of Silver Lake Park with higher concentrations along the Silver Creek and Silver Lake riparian buffers. Evergreens such as spruces and pines have been planted in very few locations. The highest evergreen concentrations are on the west side to cut down on prevailing northwest winter winds.

SITE ANALYSIS

Urban Forest: Boulevard & Riparian Buffers:



2010 Rochester, MN Boulevards:

56,779 Total Spaces

27,720 Vacant Spaces

= 29,059 Boulvard Trees
~ 51% of available spaces.

*****500 - 900 Removed annually due to diseases.**

-Jacob Ryg
Rochester, MN City Forester

LEGEND:

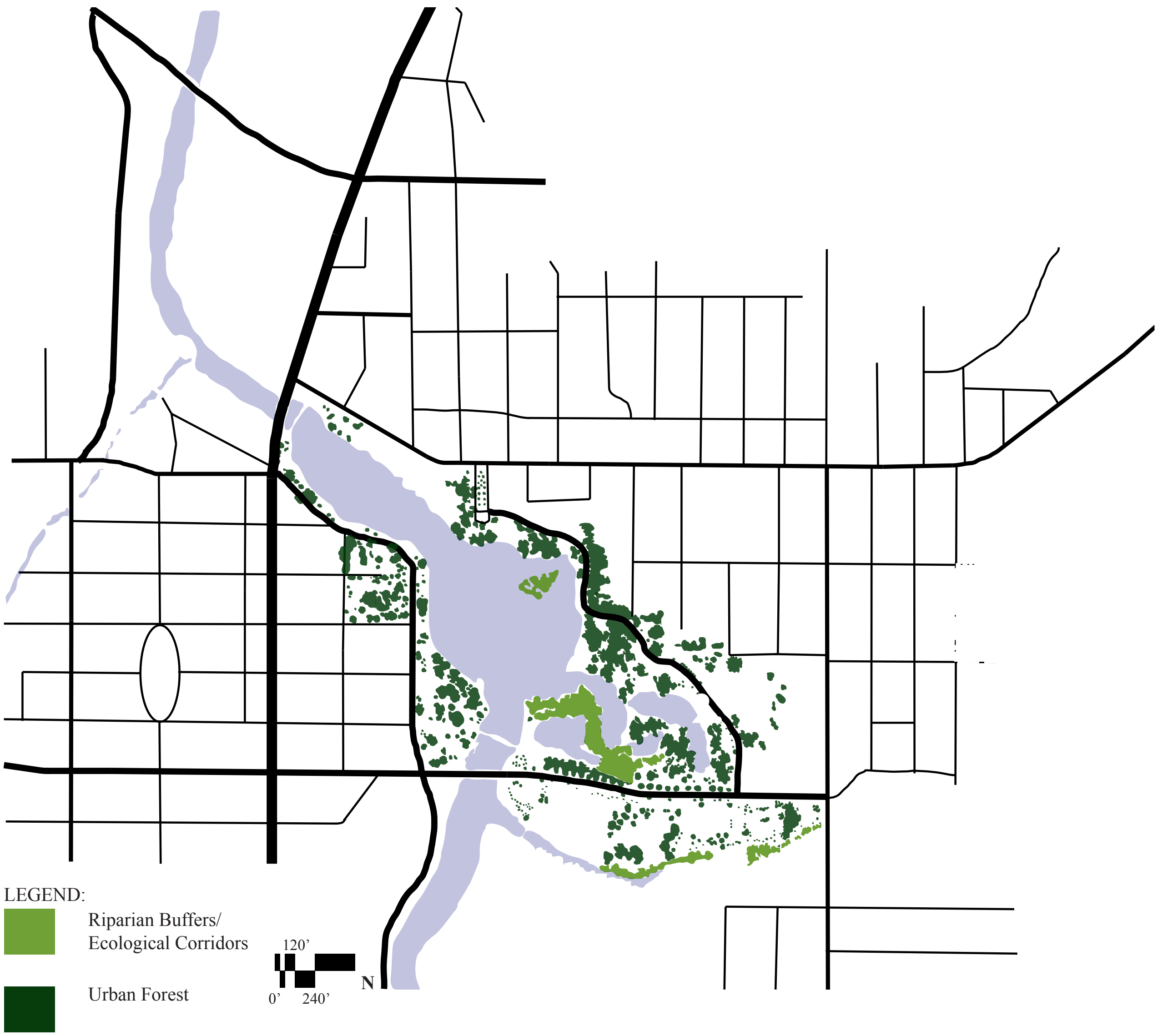
Riparian Buffers/
Ecological Corridors

Urban Forest

120’
0’ 240’
N

SITE ANALYSIS

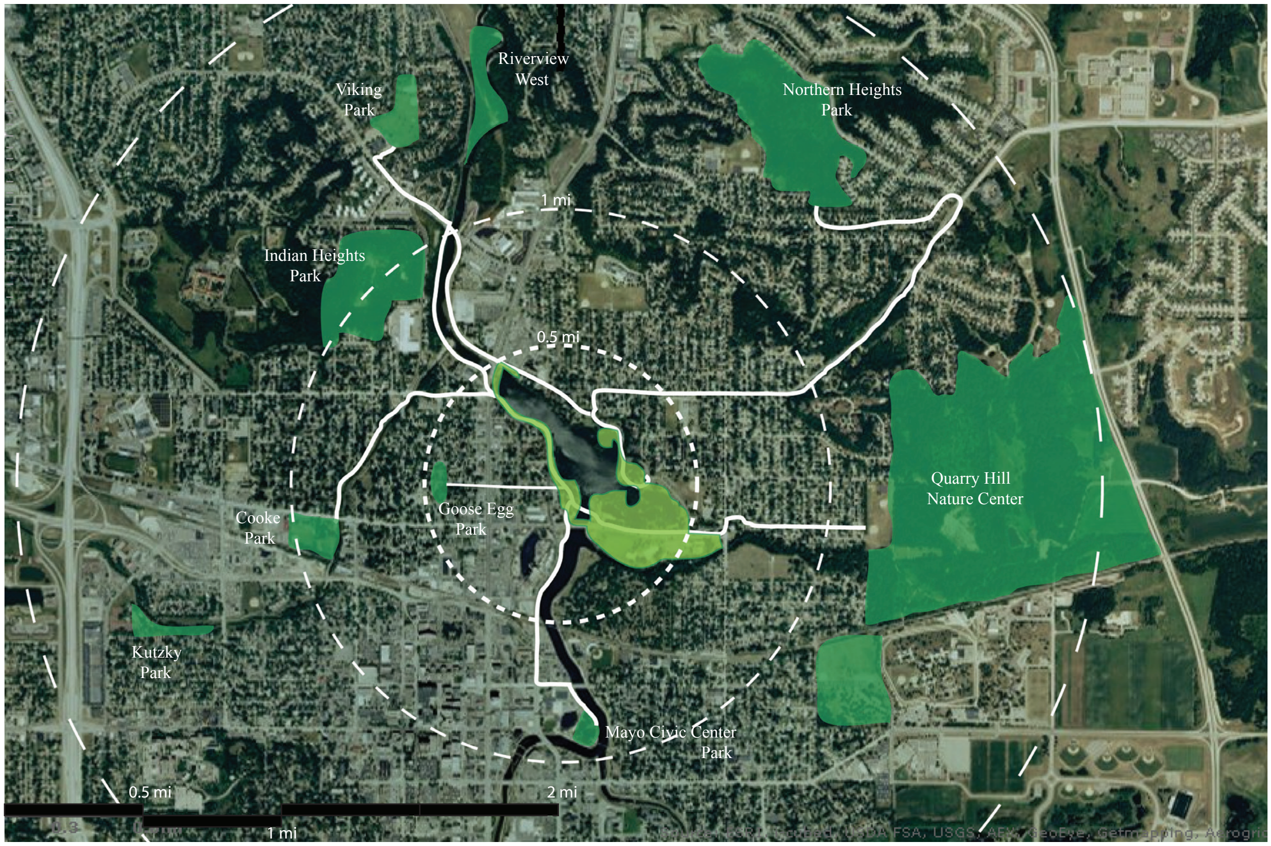
Urban Forest: Boulevard & Riparian Buffers:



Silver Lake Park contains three major riparian buffers, which have physical barriers for wildlife. An island on Silver Lake is a major nesting area for resident Giant Canadian geese.

SITE ANALYSIS

Green Networks: Silver Lake Park & Surrounding Neighborhoods

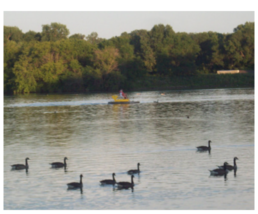


Ecological corridors are currently indirect connections through public sidewalks. The only direct park connection is to Oakwood Cemetery.

Stronger trail connections are necessary along the Zumbro River to access parks northwest of Silver Lake. Goose Egg Park is the only public neighborhood park located within a half mile of Silver Lake. A majority of exising parks consist of a mile or more whether walking or biking.

Major roads such as Broadway, 14th Ave. NE and 7th Ave. NE are physical barriers which limits pedestrian connectivity. Pedestrian safety needs to be a high priority for all main recreational trails to each public park.

Active and Passive Landscapes: Silver Lake Park



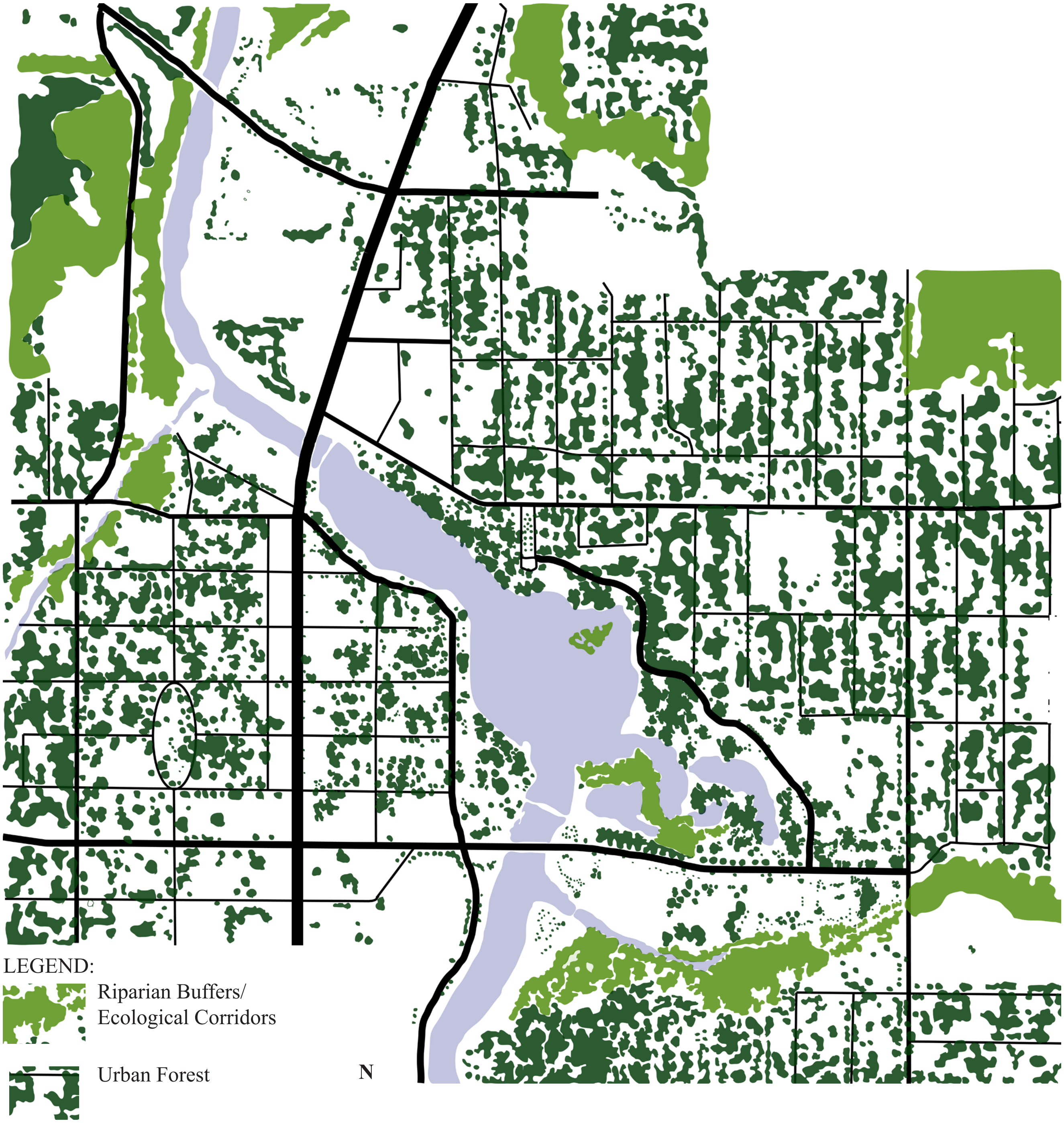
Active Spaces: Recreational Trails & Activities

Passive Spaces: Naturalized Plantings & Minimal Used Lawn

Active spaces are balanced throughout Silver Lake Park. Playgrounds are situated on the east and west sides of the park. Passive spaces; however, consist of an imbalance between open lawn and naturalized plantings. Humans and wildlife are able to interact with each other, but can be confrontational when young geese and ducks are present.

SITE ANALYSIS

URBAN & RIPARIAN BUFFERS:



Riparian buffers contain many deciduous plant species such as American elm, American linden, common hackberry, green ash and silver maple. The riparian buffers serve as scattered areas of sediment filtration of urban runoff into either bear, cascade or silver creek. Urban runoff is a distinct problem surrounding Silver Lake Park due to minimal existing riparian buffers.

Ecological corridors are fragmented by a mosaic of urban development. Existing roads are physical barriers that make it less suitable for wildlife movement between each public green space.

SITE ANALYSIS

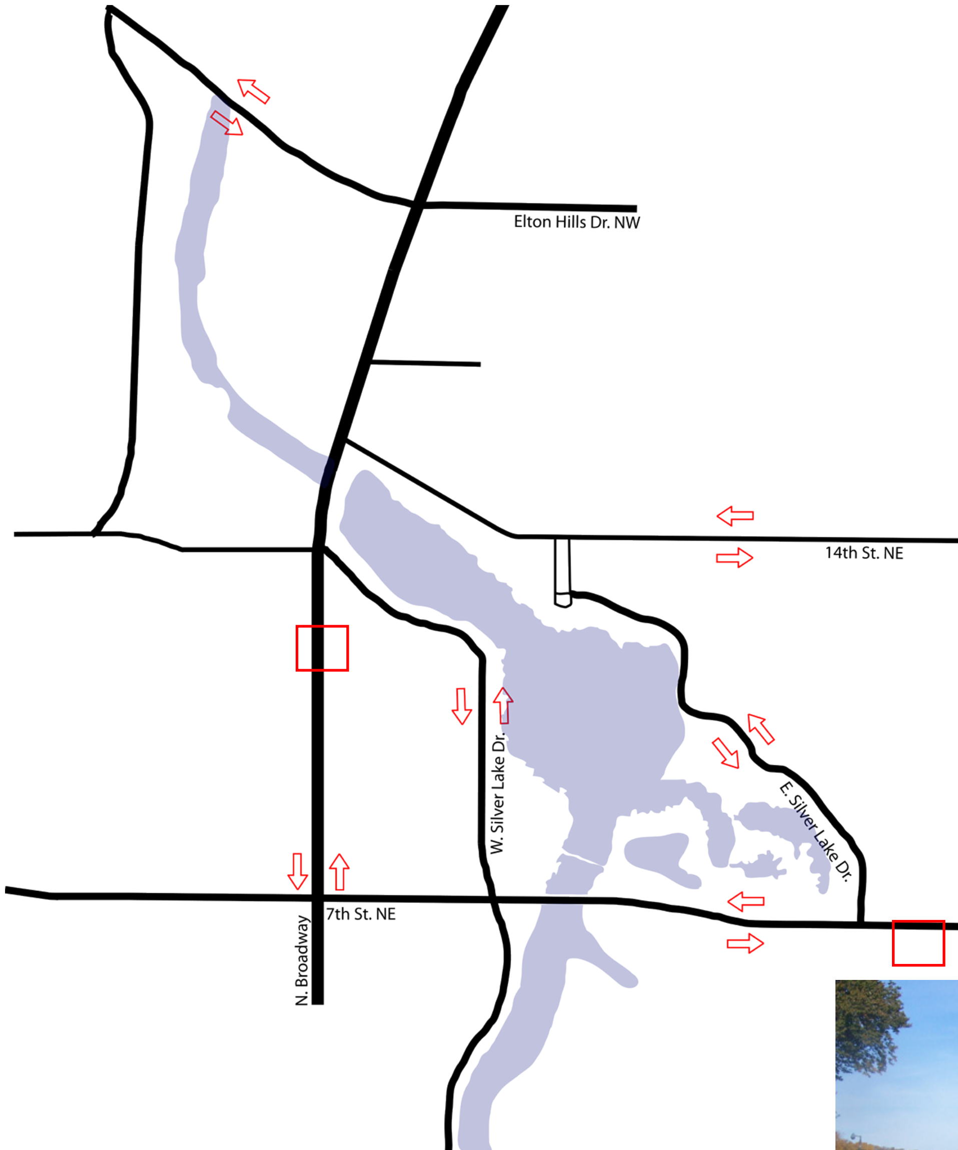
ROAD ANALYSIS:

North Broadway is the main road separating Silver Lake Park from the Northrup neighborhood. West Silver Lake Dr, East Silver Lake Dr, 7th St. N and 14th St. N. separate the East Pioneers and Glendale neighborhoods from Silver Lake Park.

Vehicular dominance on roads makes it more difficult for surrounding neighbors to walk or bike directly without finding an alternate route. An alternate route for East Pioneer neighborhood residents is taking 3rd Ave. N west until they reach the Zumbro River bike trail.

SITE ANALYSIS

ROAD ANALYSIS:



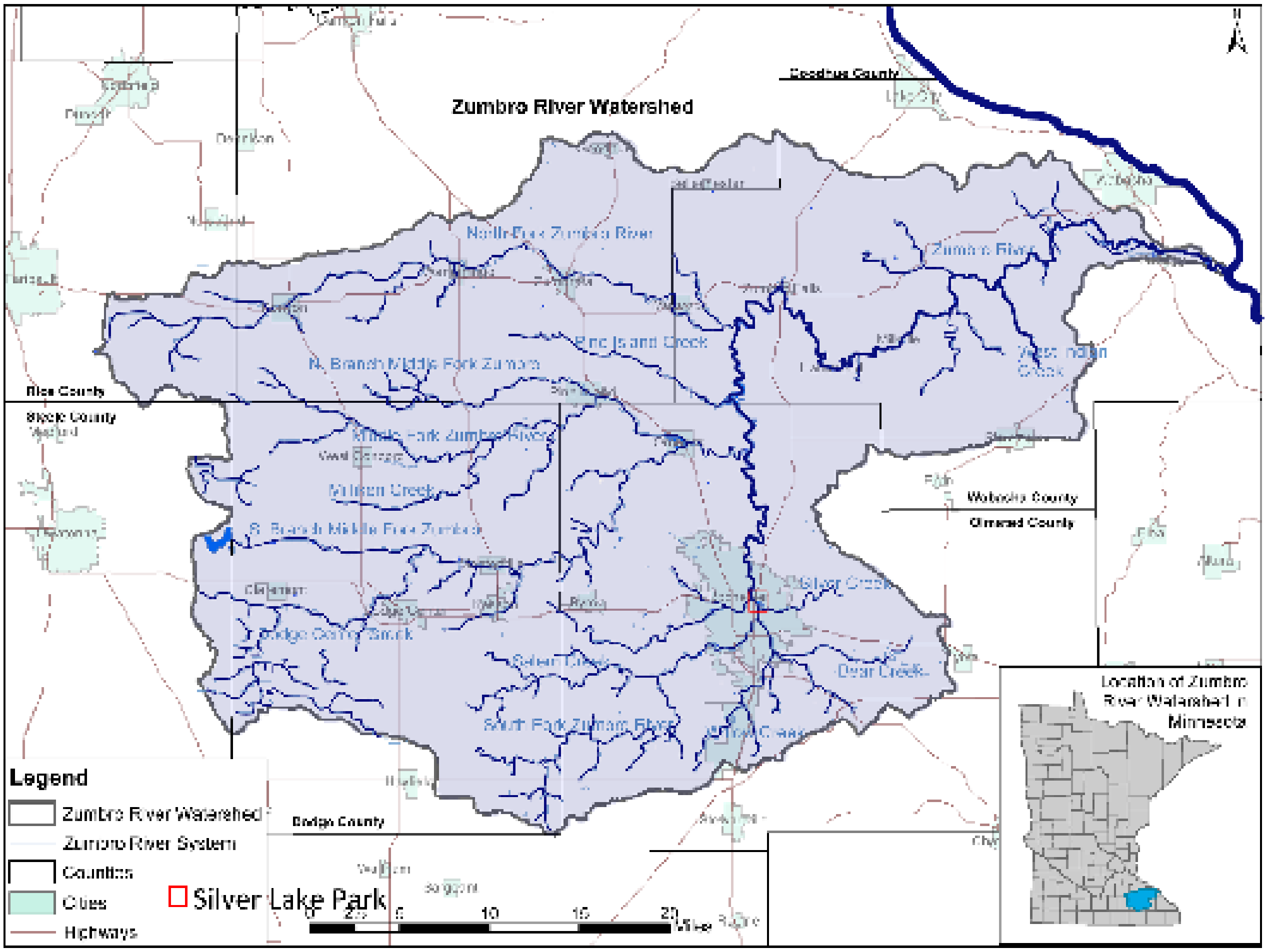
Two way traffic is evident on all major roads surrounding Silver Lake Park. Thirty-five mph traffic on 7th St. NE is an existing problem that divides Silver Lake Park from the public swimming pool, skate park and children's playground. Traffic control methods must be implemented to ensure the safety and welfare of park users.

West Silver Lake Dr. has recently experienced many people losing control around the northwest curve. I have noticed from personal observation that pedestrian crossing is a major safety issue needing to be addressed. It is difficult to see vehicles speeding around the corner from the intersection of North Broadway and West Silver Lake Dr.

SITE ANALYSIS

ZUMBRO WATERSHED ANALYSIS:

Zumbro River Watershed: Six County Region

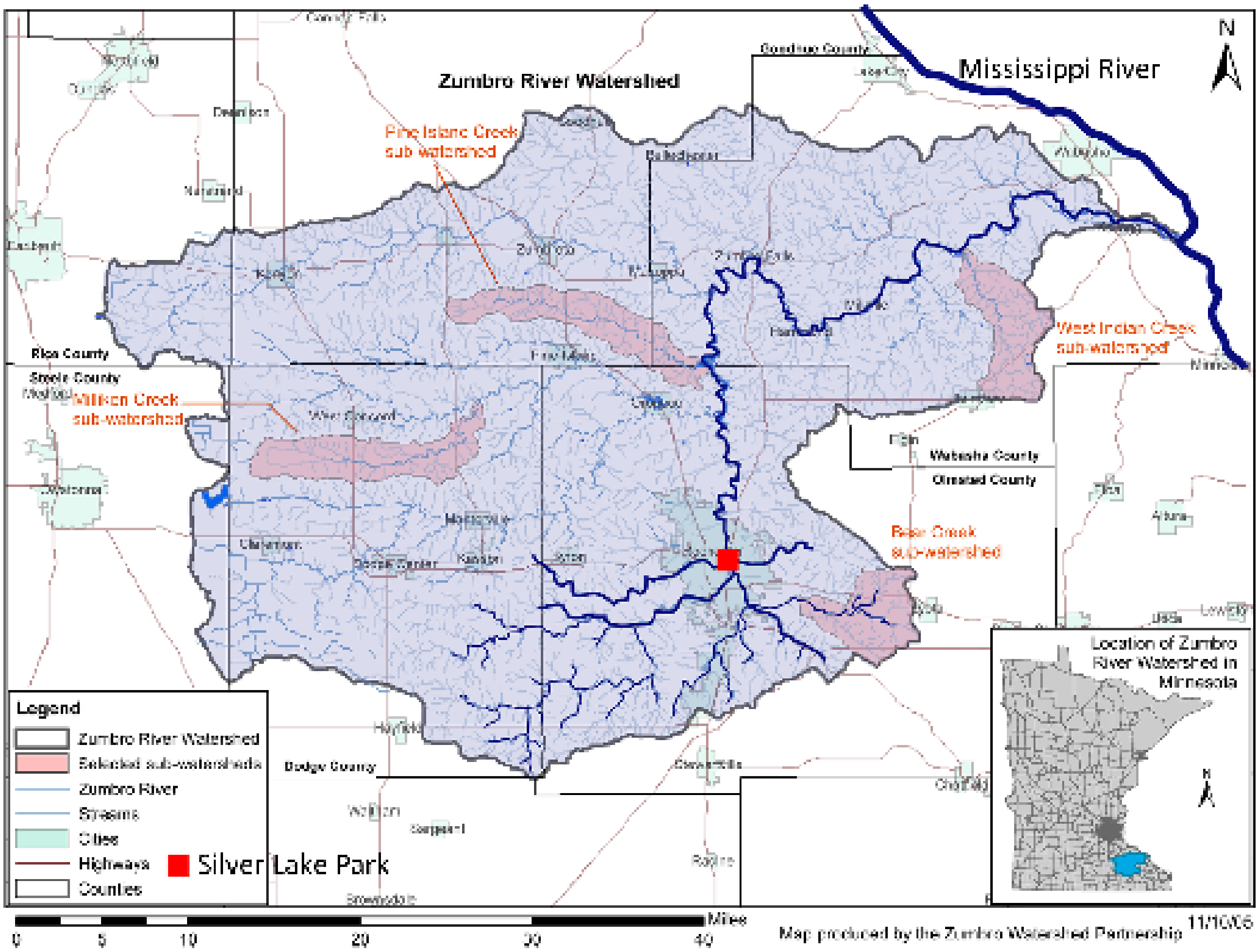


A complex network of creeks, streams and rivers are tightly integrated for the Zumbro Watershed. A design either upstream or downstream can have negative consequences for the regional hydrology cycle. Designs must increase vegetated buffers to replace the former riparian corridors to help minimize urban pollution loads into Silver Lake and its networks. Stormwater runoff can be better managed in urban parks to include more vegetation besides Kentucky bluegrass dominated lawns.

The Silver Lake vegetated buffers are only the beginning to a more holistic design solution that focuses on biodiversity and increases a landscape's ecological resilience. An engineered solution cannot be relied on as the only method of averting a pending disaster- flooding.

ZUMBRO WATERSHED ANALYSIS:

Zumbro River Watershed and Sub-watersheds in SE Minnesota

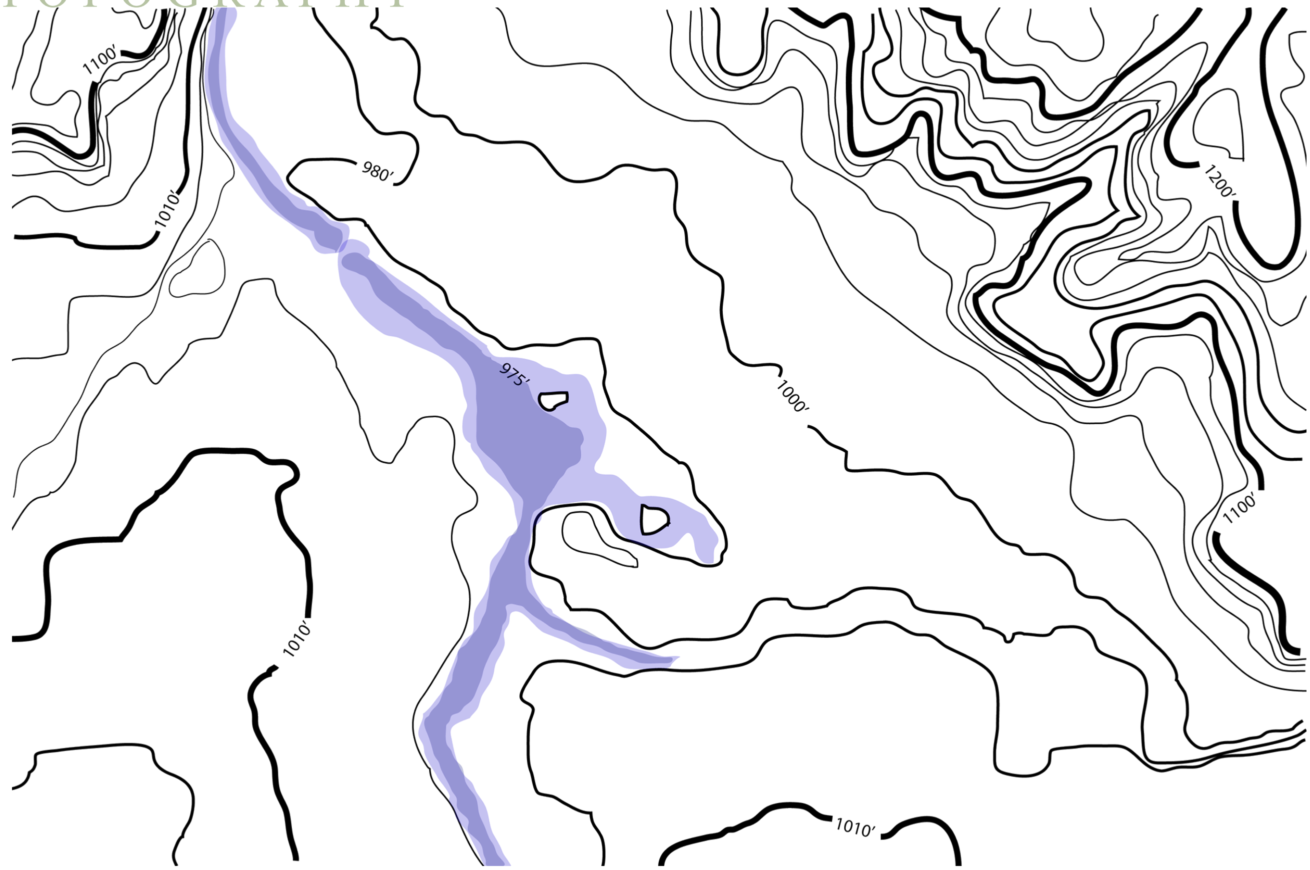


Silve Lake is at the convergence of Bear, Cascade and Silver Creek, which move water into the Zumbro River. The Zumbro River then transports water past the Silver Lake dam and northeast towards the Mississippi River. Our actions impact the regional hydrology both in the short and long-term. Planning strategies such as increasing riparian buffers to minimize urban pollution runoff into the Zumbro River must be a high priority.

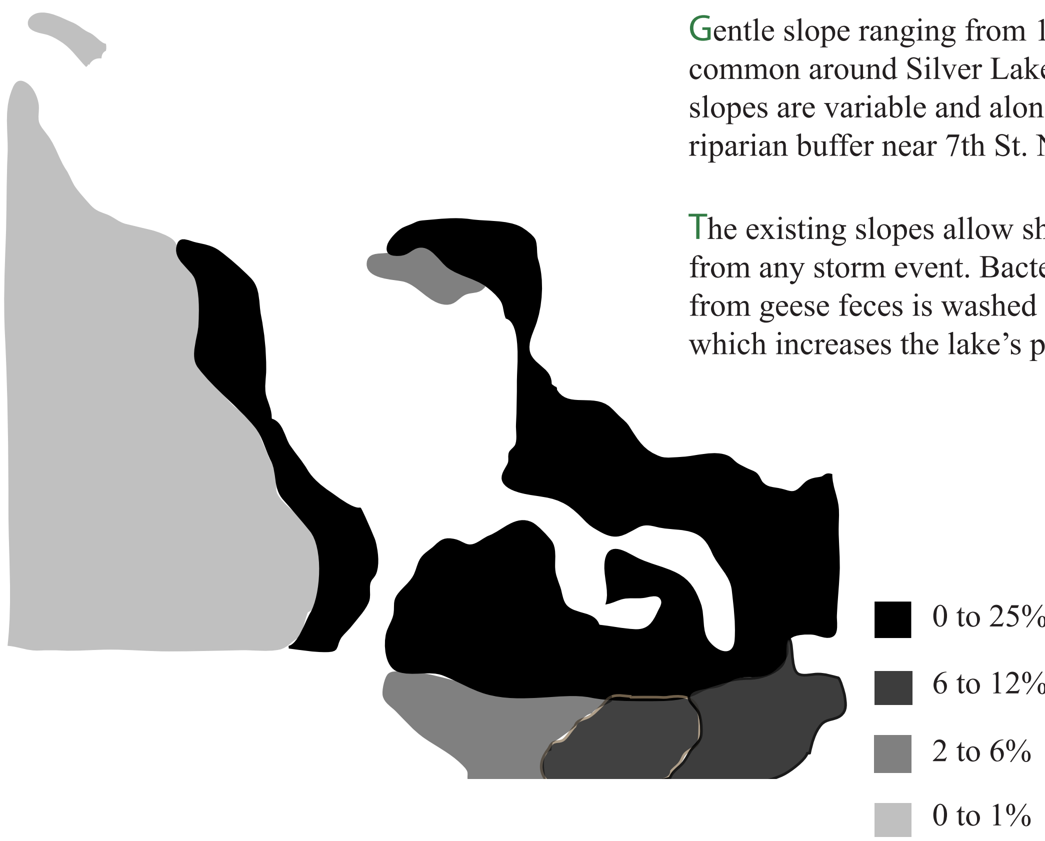
Regional flooding is in response to the human modifications that have impacted former ecological processes. Trees serve as hydraulic pumps in which they are able store stormwater during the growing season. Adaptable trees that are site-specific to Silver Lake Park are important to the site's environment ranging from site soil composition to hydrology.

SITE ANALYSIS

TOPOGRAPHY



SLOPE ANALYSIS:

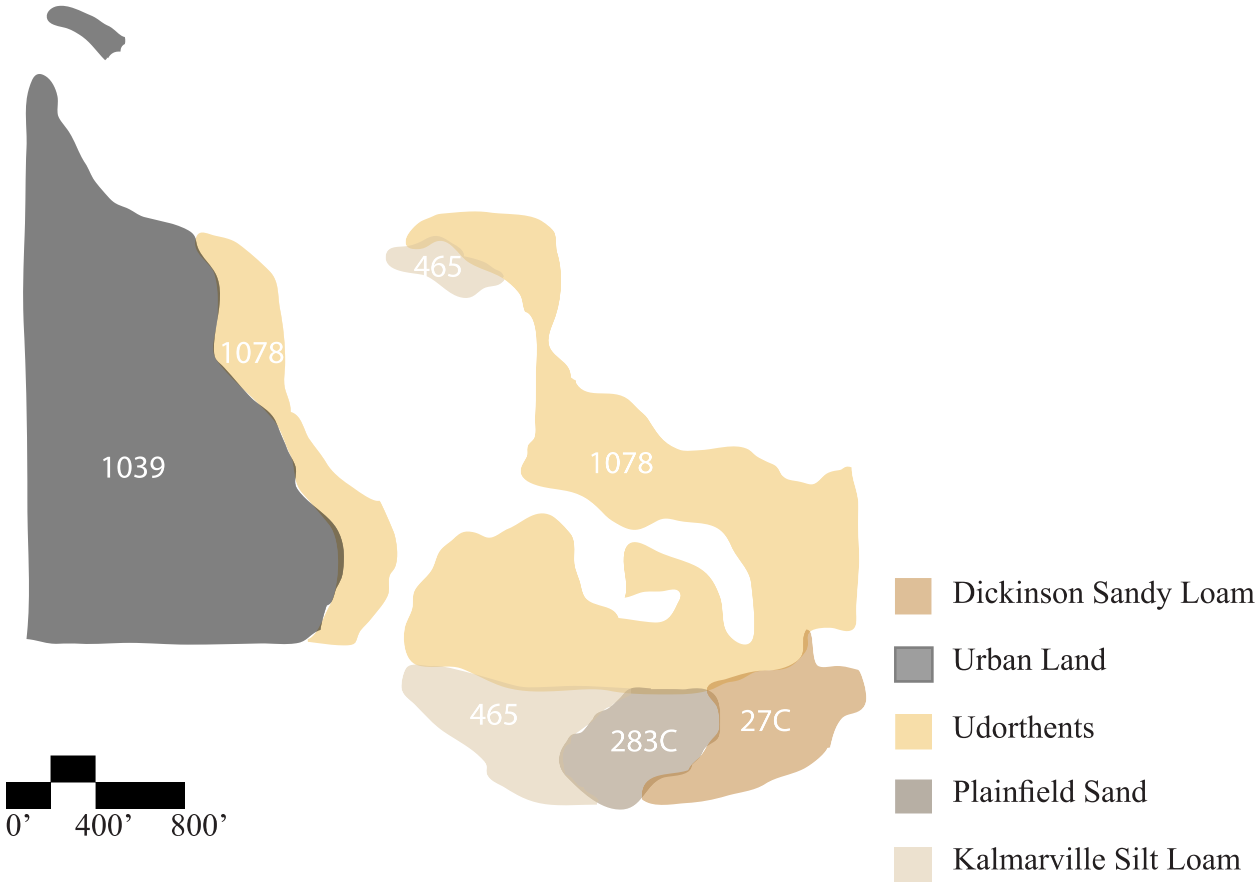


Gentle slope ranging from 1 to 12% are common around Silver Lake Park. Steeper slopes are variable and along the undisturbed riparian buffer near 7th St. N.

The existing slopes allow sheet flow runoff from any storm event. Bacterial coliform from geese feces is washed into Silver Lake, which increases the lake's pollution load.

SITE ANALYSIS

SOIL SURVEY:



Dickinson Sandy Loam:

0 to 15 inches: Sandy loam
15 to 28 inches: Sandy loam
28 to 60 inches: Sand

Depth to Water Table: > 80 inches
Available Water Holding Capacity: Low: 4.9 inches

Urban Land:

0 to 60 inches: Variable soil material

Depth to Water Table: > 80 inches
Available Water Holding Capacity: n/a

Udorthents:

0 to 60 inches: Variable soil material

Depth to Water Table: > 80 inches
Available Water Holding Capacity: Well Drained

Plainfield Sand:

0 to 6 inches: Sand
6 to 21 inches: Sand
21 to 60 inches: Sand

Depth to Water Table: > 80 inches
Available Water Holding Capacity: Low: 3.3 inches

Kalmarville Silt Loam:

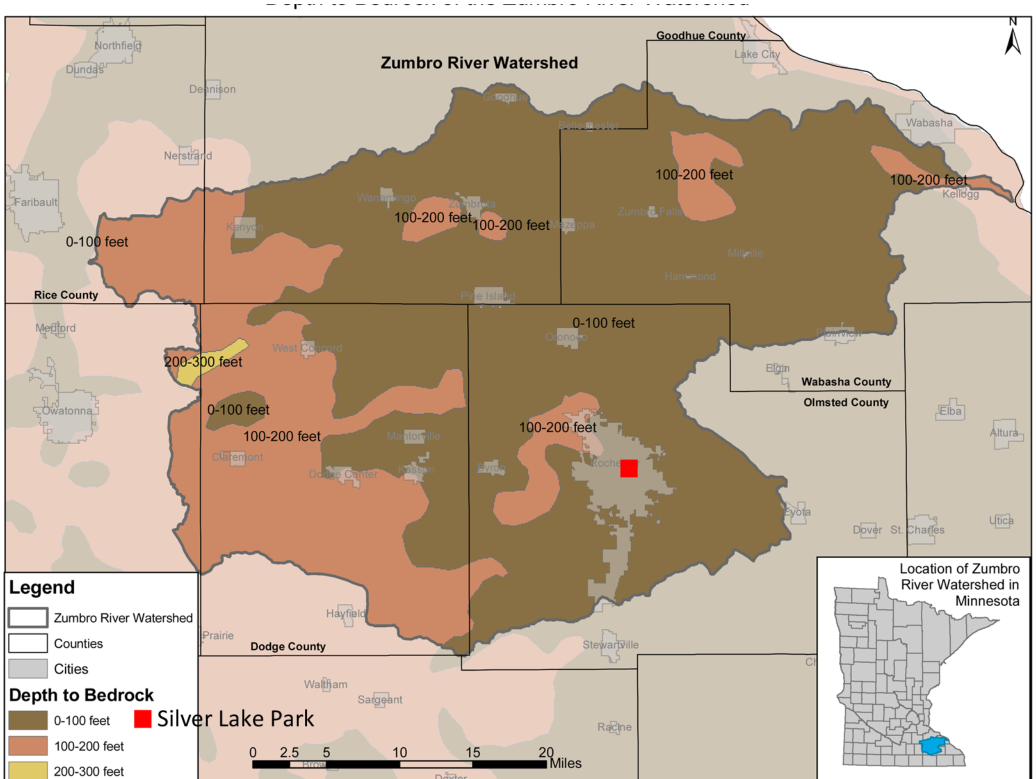
0 to 10 inches: Silt Loam
10 to 43 inches: Sand
43 to 60 inches: Sand

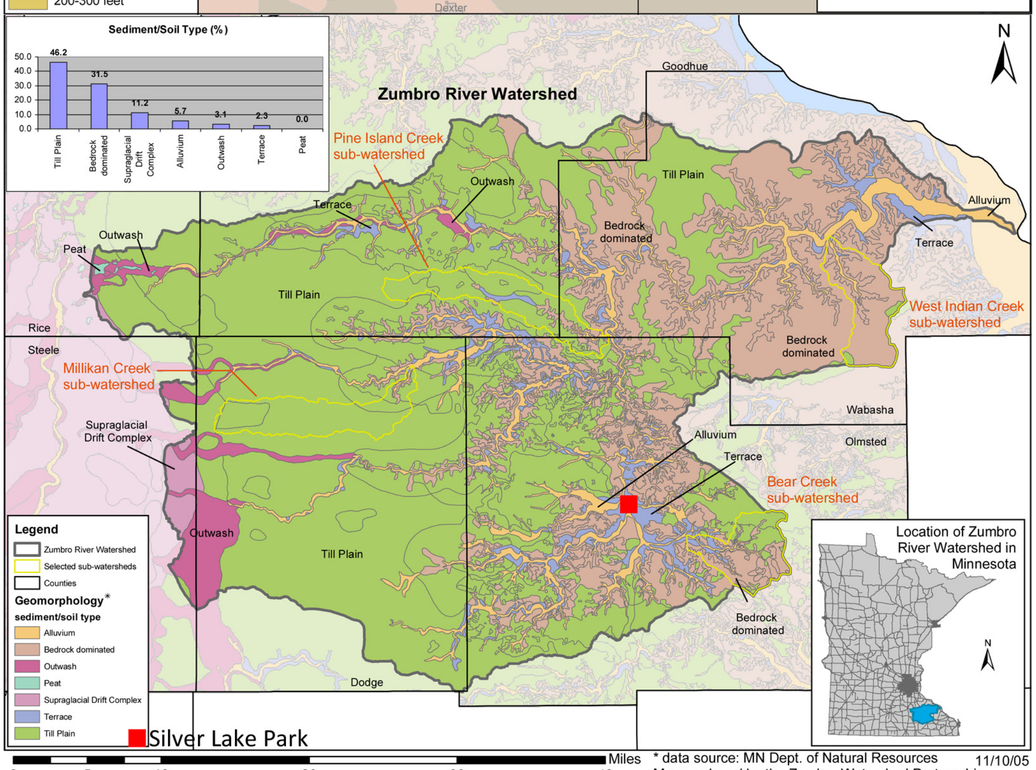
Depth to Water Table: > 80 inches
Available Water Holding Capacity: Moderate: 8.8 inches

Credit: NRCS 2010

G E O L O G Y

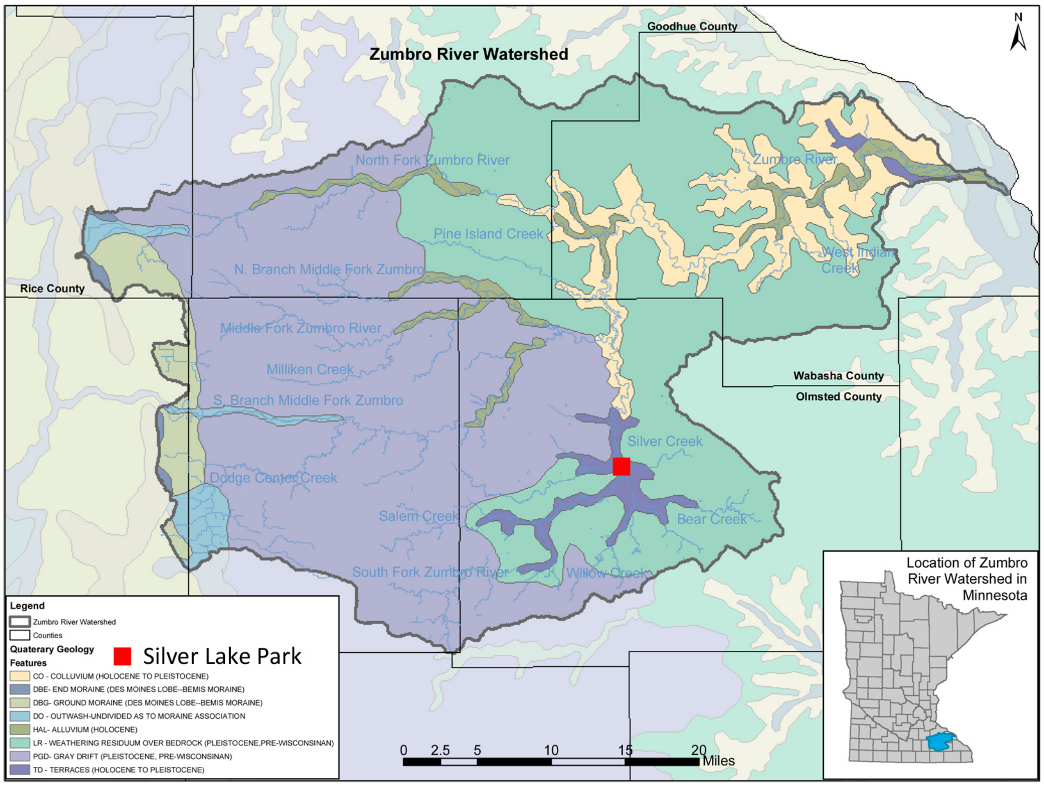
Bedrock Depth & Geomorphology-Sediment Composition

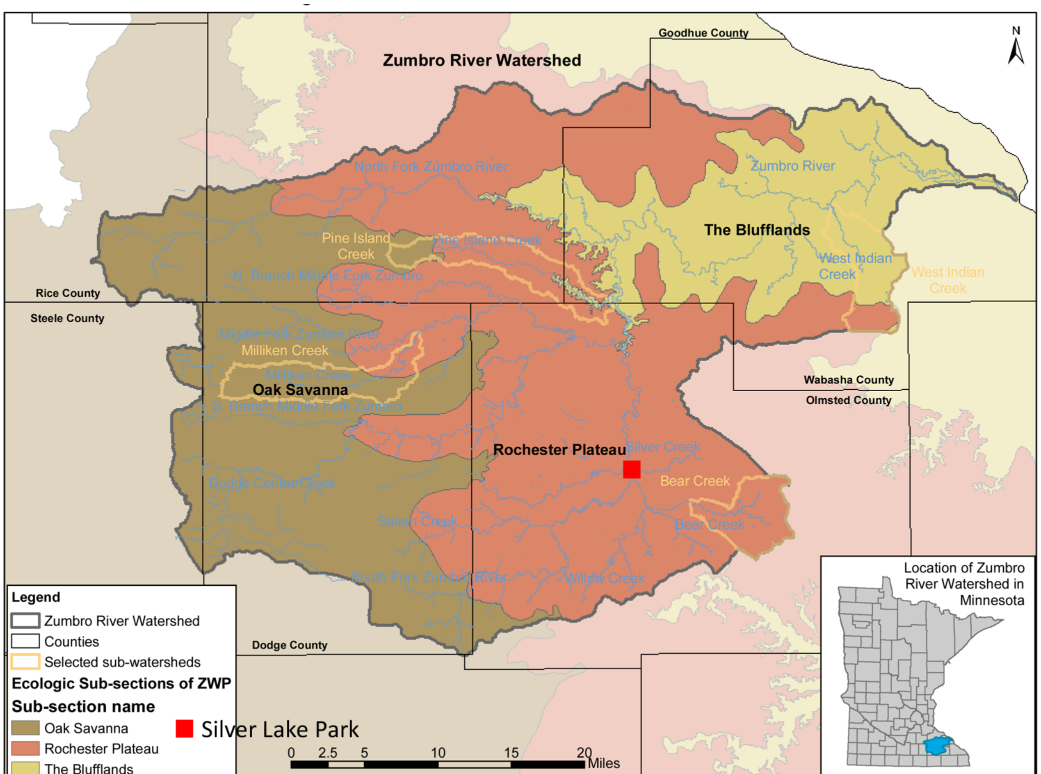




Credit: (ZWP, INC 2005), additions by Jacob Berg

GEOLOGY: QUARTERARY & ECOLOGY SUBSECTIONS
Quaternary Geology & Ecological Sub-Sections



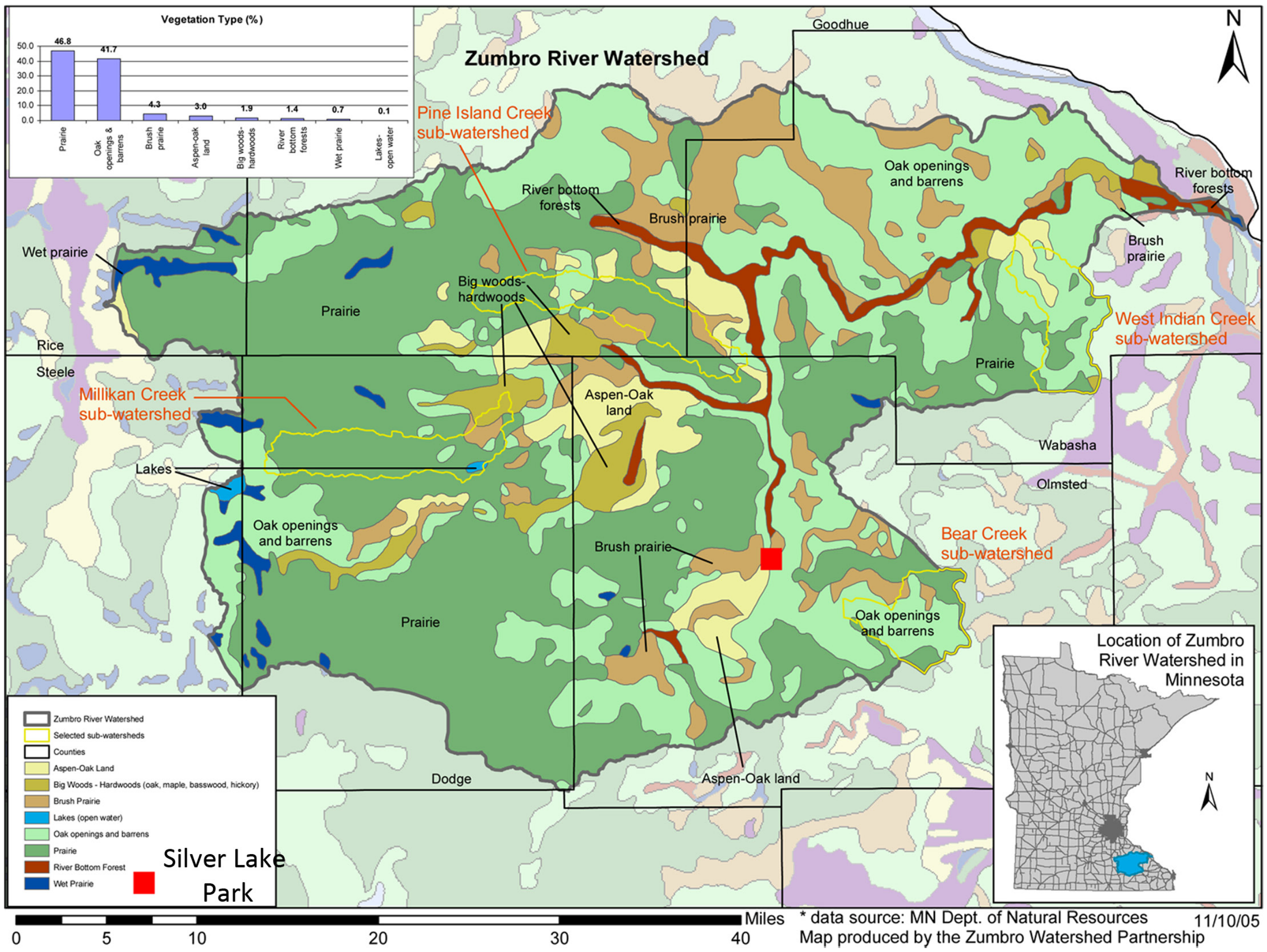


Credit: (ZWP, INC 2005), additions by Jacob Berg

PRE-SETTLEMENT VEGETATION

Zumbro River Watershed: Silver Lake Park

Aspen-Oak Land, Brush Prairie & Oak Openings/ Barrens

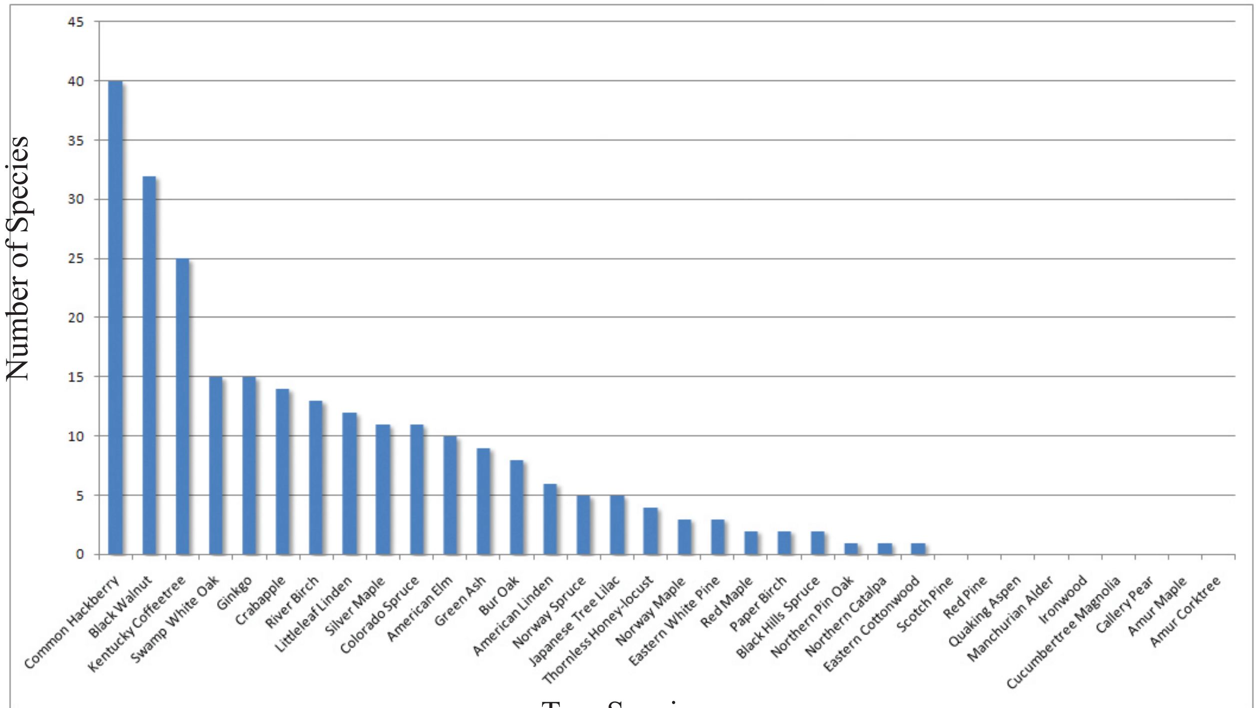


Credit: (ZWP, INC 2005), additions by Jacob Berg

Ecological pre-settlment vegetation at Silver Lake consisted of aspen-oak land, brush prairie and oak opening/barrens. Currently, quaking aspen are a scarce tree at the Silver Lake due to years of human modifications. Quaking aspen are the most adaptable tree in riparian buffers due to their extensive clonal root systems. Oak groves, on the other hand, are still established in select areas near the east picnic shelter.

Prairies have been replaced by high maintenance Kentucky bluegrass. Kentucky bluegrass is a major constituent of the existing urban ecosystem. Its presence provides forage for the large populations of Giant Canadian Geese. The Silver Lake buffer project contains native warm and cool season grasses mixed in with a high percentage of herbaceous forbs. Forbs have recently been dominating the 3 year old buffer and outcompeting the grasses.

Silver Lake Park Tree Inventory & Longevity:



Tree Inventory & Tree Age Calculations
conducted by Jacob Berg from March - October 2010

Tree Species:	
Acer platanoides	
Acer rubrum	
Acer saccharinum	
Acer saccharum	
Betula nigra	
Betula papyrifera	
Catalpa speciosa	
Celtis occidentalis	
Fraxinus pennsylvatica	
Ginkgo biloba	
Gleditsia tricanthos var. inermis	
Gymnocladus dioica	
Juglans nigra	
Malus ssp.	
Picea glauca va. densata	
Picea pungens	
Populus deltoides	
Quercus bicolor	
Quercus ellipsoidallis	
Quercus macrocarpa	
Tilia americana	
Tilia cordata	
Ulmus americana	

*Cofactor courtesy of ISA Tree Valuation Booklet, 7th Ed.

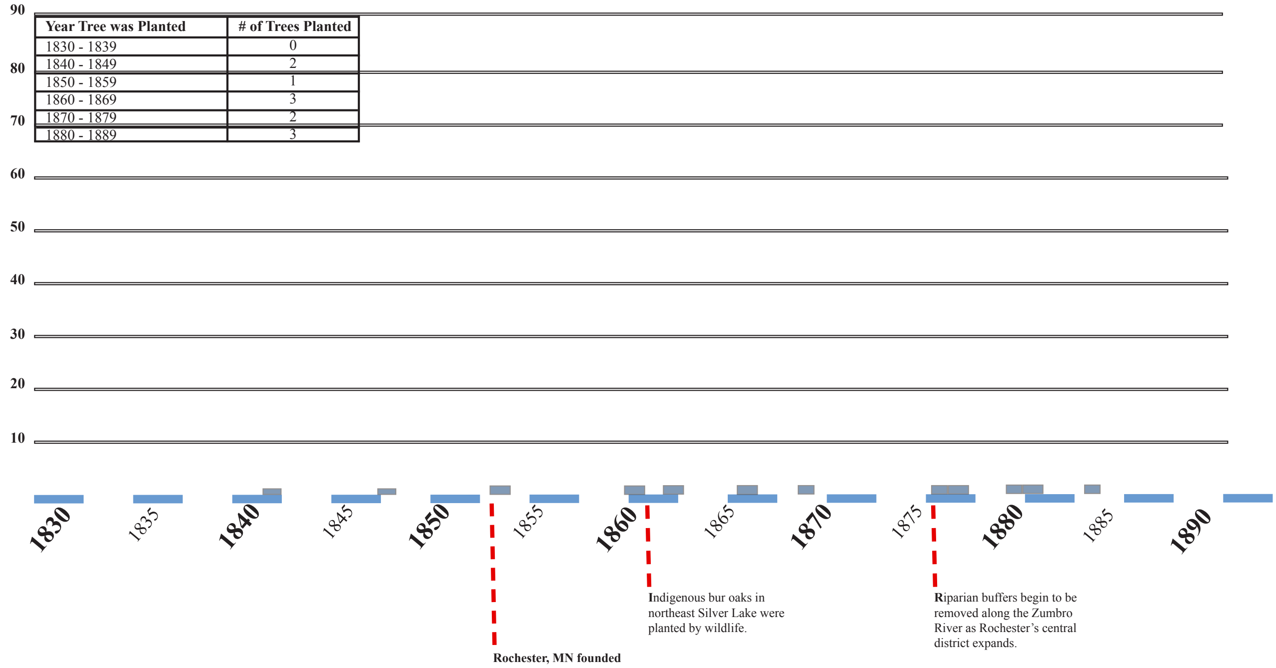
Approximate Tree Age: **Cofactor x Diameter in inches at 4.5 feet above ground level**

I.e. Common Hackberry with 13.37” diameter

4.0 x 13.37in ~ 54 years old

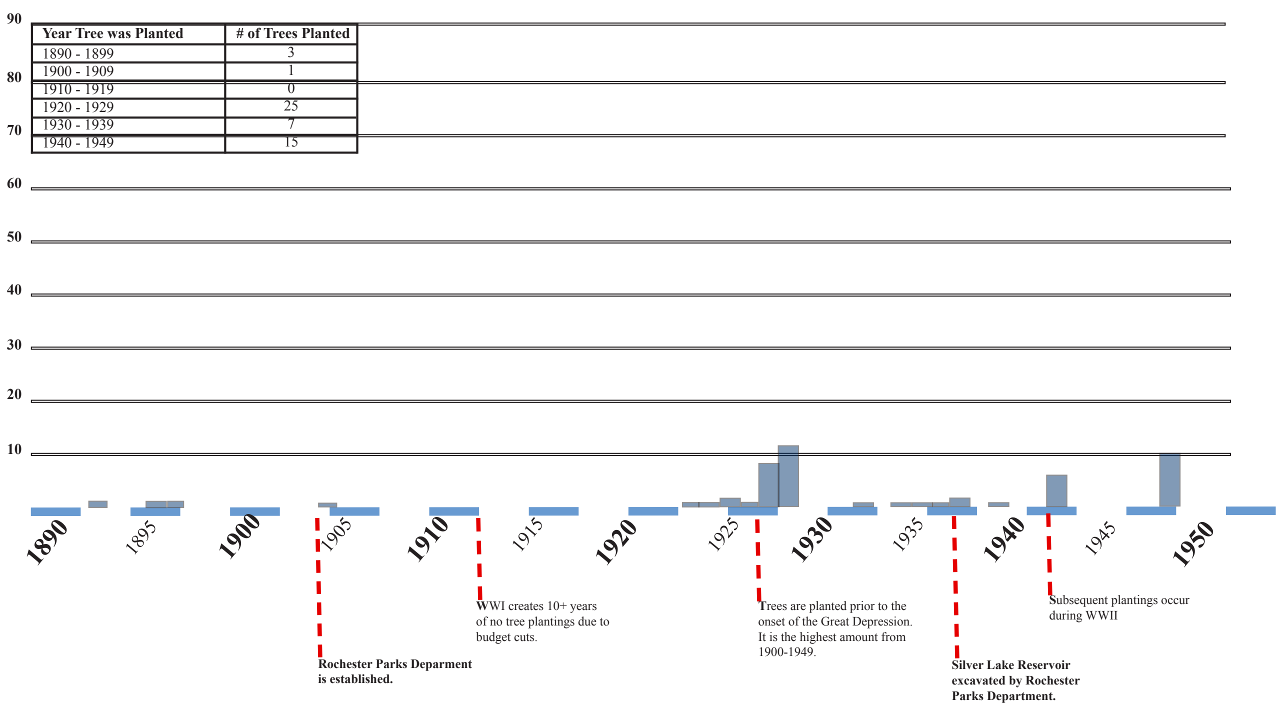
Estimated Tree History: 1830 - 1890

Year Tree was Planted	# of Trees Planted
1830 - 1839	0
1840 - 1849	2
1850 - 1859	1
1860 - 1869	3
1870 - 1879	2
1880 - 1889	3



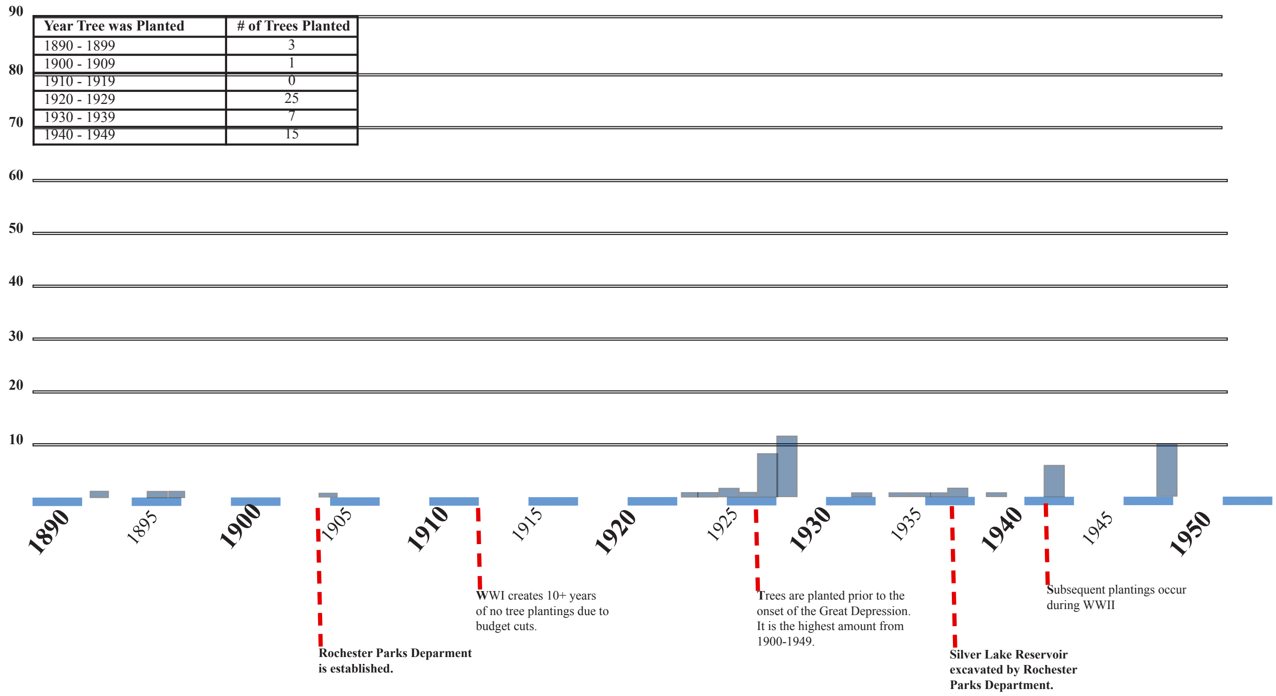
Estimated Tree History: 1890 - 1950

Year Tree was Planted	# of Trees Planted
1890 - 1899	3
1900 - 1909	1
1910 - 1919	0
1920 - 1929	25
1930 - 1939	7
1940 - 1949	15

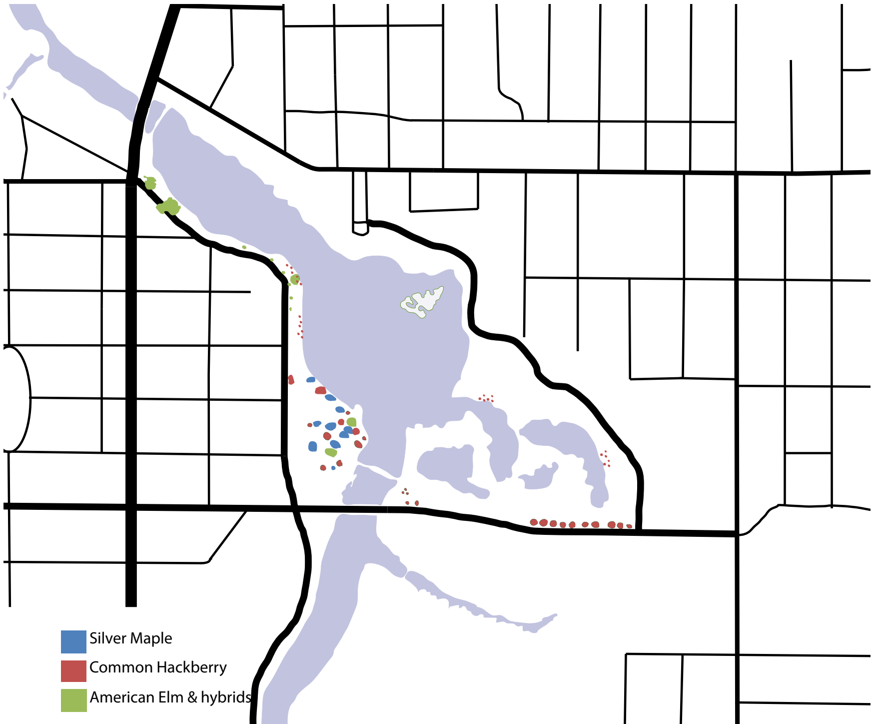


Estimated Tree History: 1950 - 2010

Year Tree was Planted	# of Trees Planted
1890 - 1899	3
1900 - 1909	1
1910 - 1919	0
1920 - 1929	25
1930 - 1939	7
1940 - 1949	15

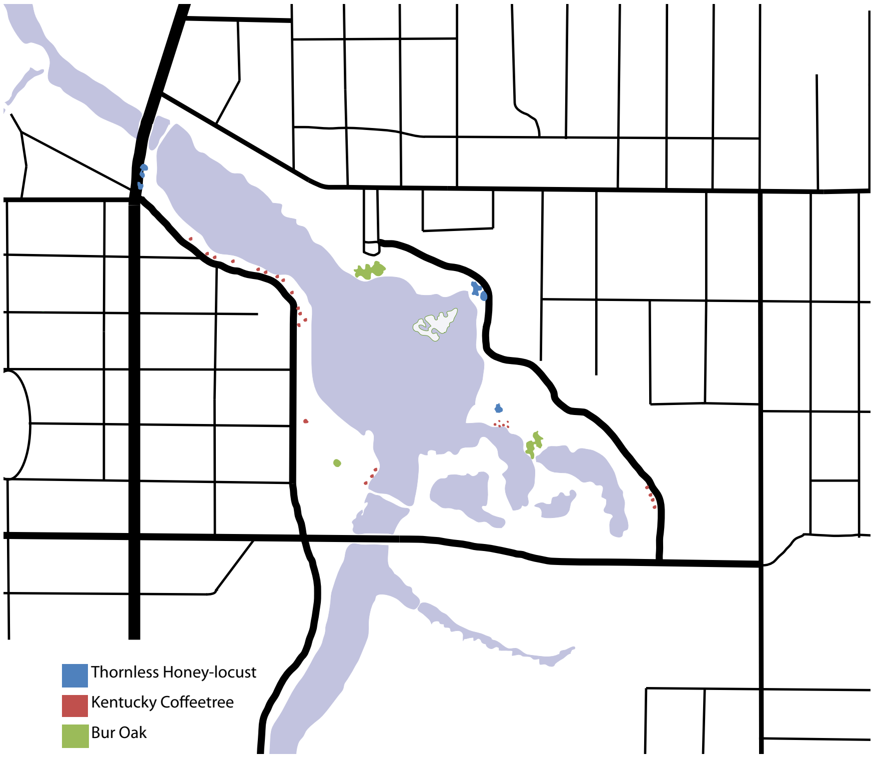


Tree Inventory: Silver Lake Park



Silver maple, common hackberry and American elm dominate the west side of Silver Lake Park.

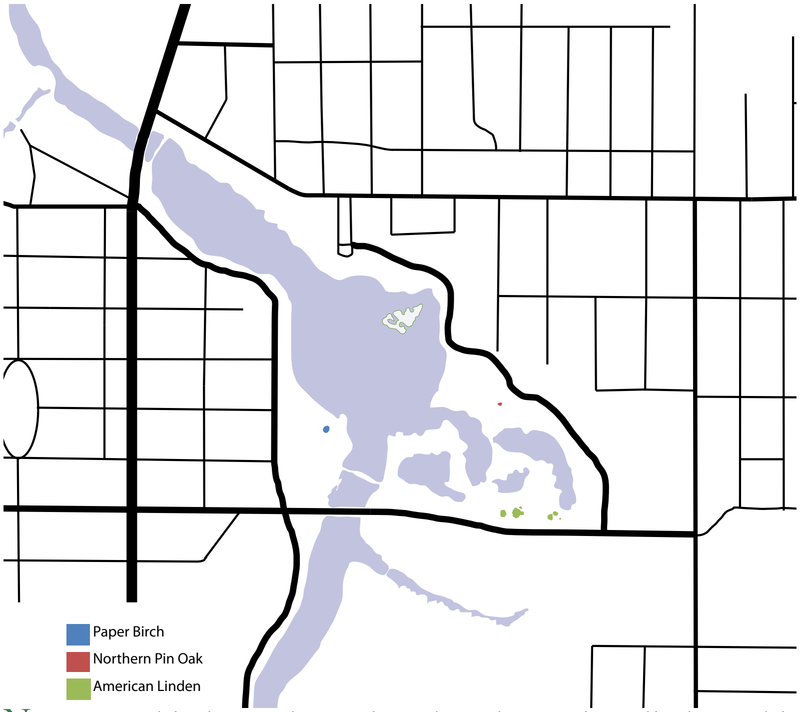
Common hackberry is the number one tree species at Silver Lake Park.



Kentucky Coffeetree is a recent and underutilized addition to the site's biodiversity.

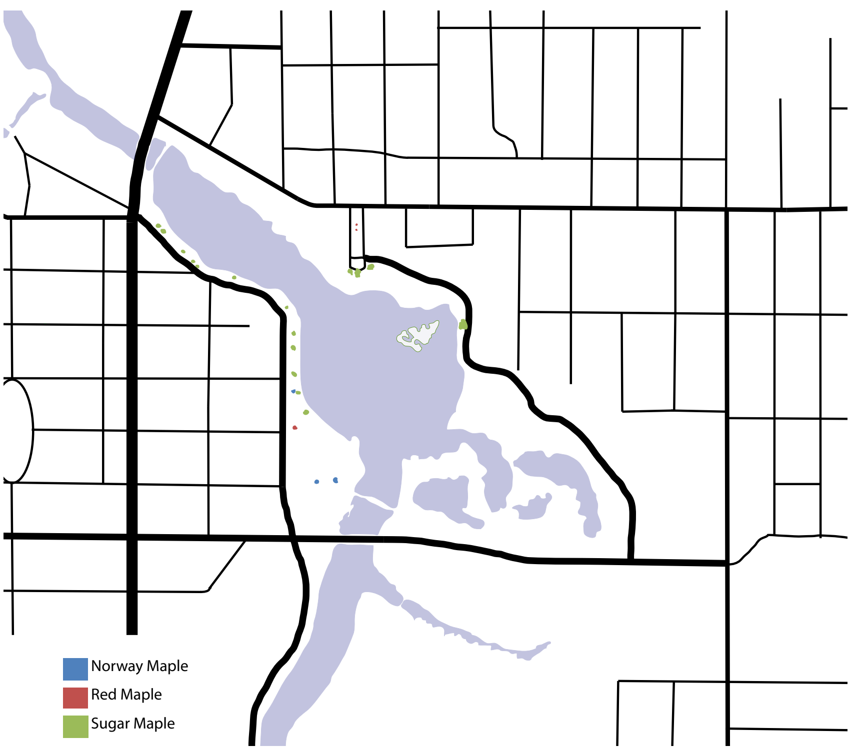
Indigenous bur oaks have survived urban development for over a century.

Tree Inventory: Silver Lake Park



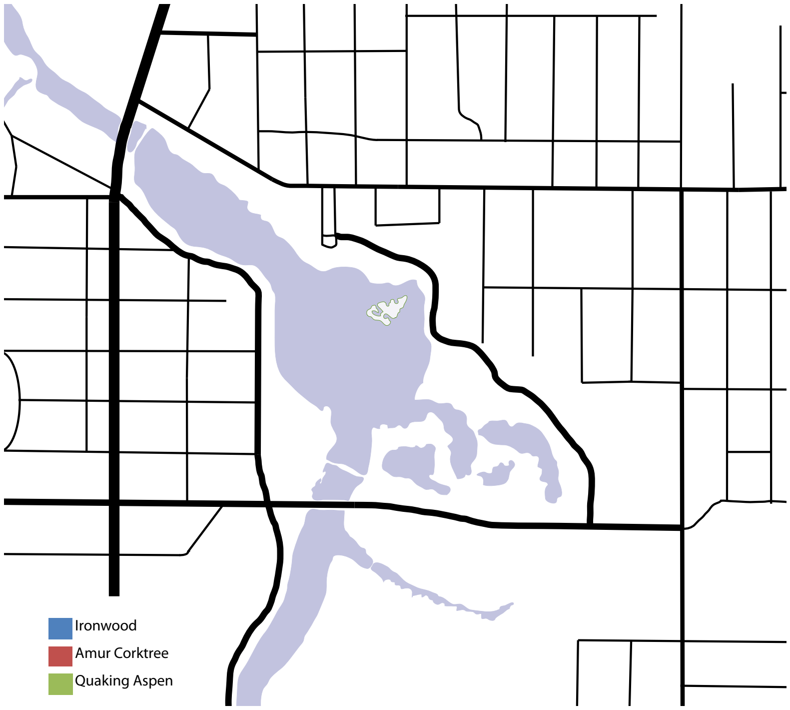
New paper birch, northern pin oak and American linden cultivars merit planting at Silver Lake Park.

Oak wilt is a fungal problem in MN, which explains low pin and red oak populations.

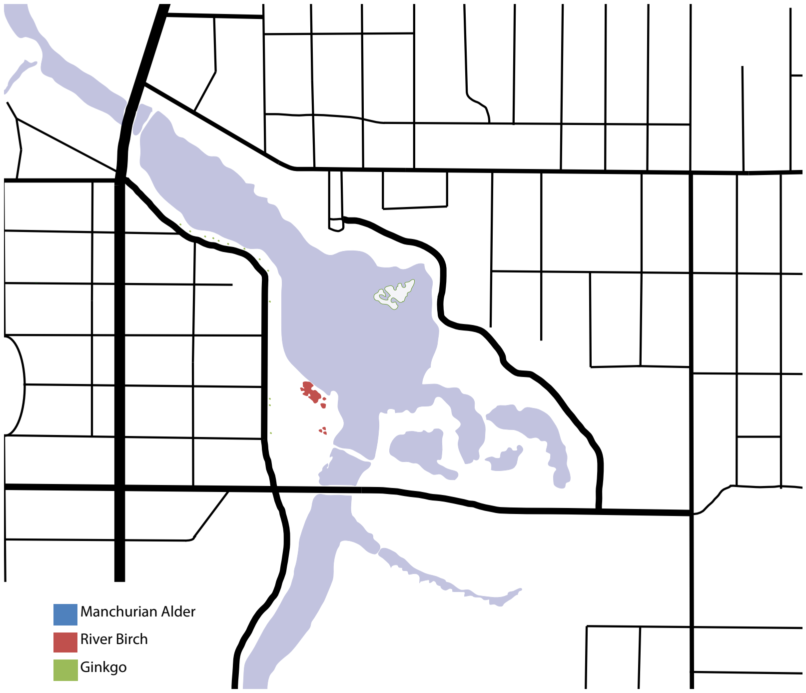


Sugar maples are the dominant species for red to orange fall colors. West Silver Lake Road is lined with straight species of sugar maples.

Tree Inventory: Silver Lake Park



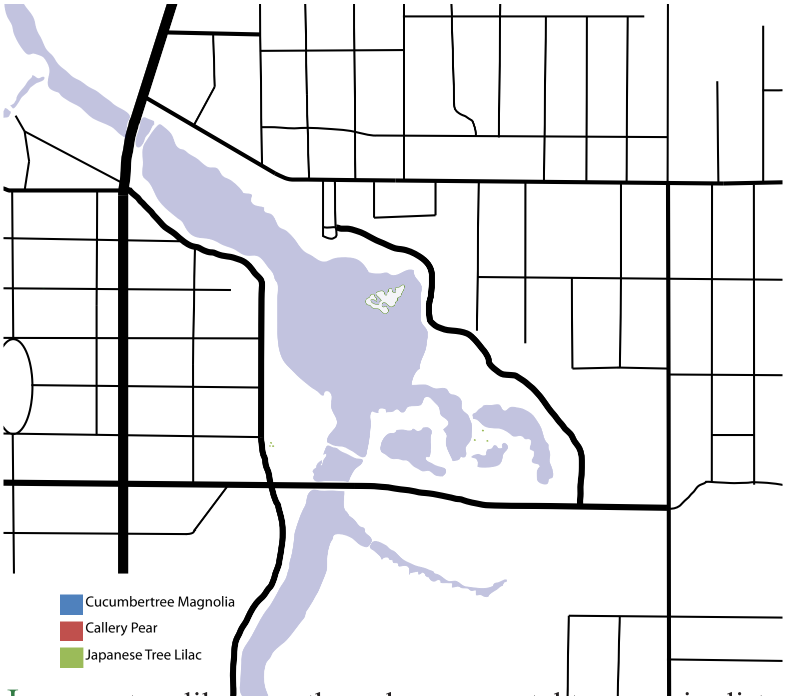
Ironwood, Amur corktree and quaking aspen do not currently exist at Silver Lake Park. The addition of these trees would increase Silver Lake Park's long-term resilience.



River birches have established well due to a high water table. Exfoliating bark adds winter interest for site users.

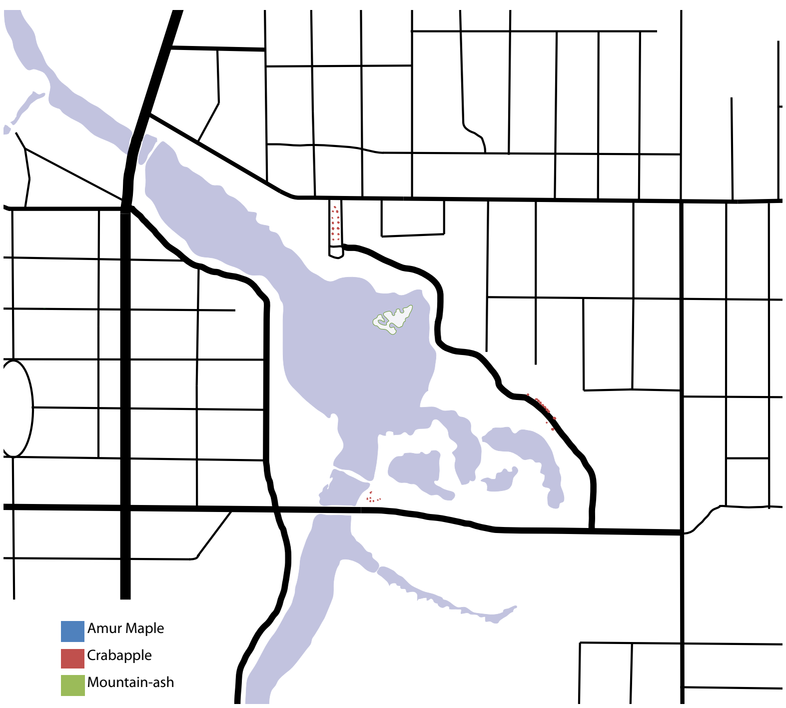
Ginkgos are gaining popularity in Rochester due to pollution tolerance.

Tree Inventory: Silver Lake Park



Japanese tree lilacs are the only ornamental tree species listed growing at Silver Lake.

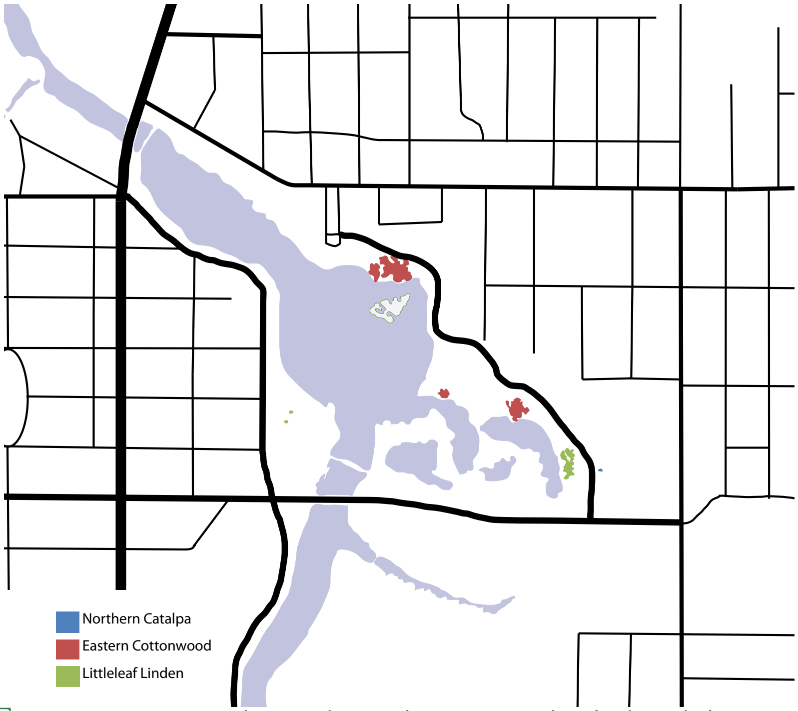
Cucumbertree magnolias and 'Autumn Blaze' callery pear are spring blooming trees.



Older rosybloom crabapple lined the north entrance median into Silver Lake Park.

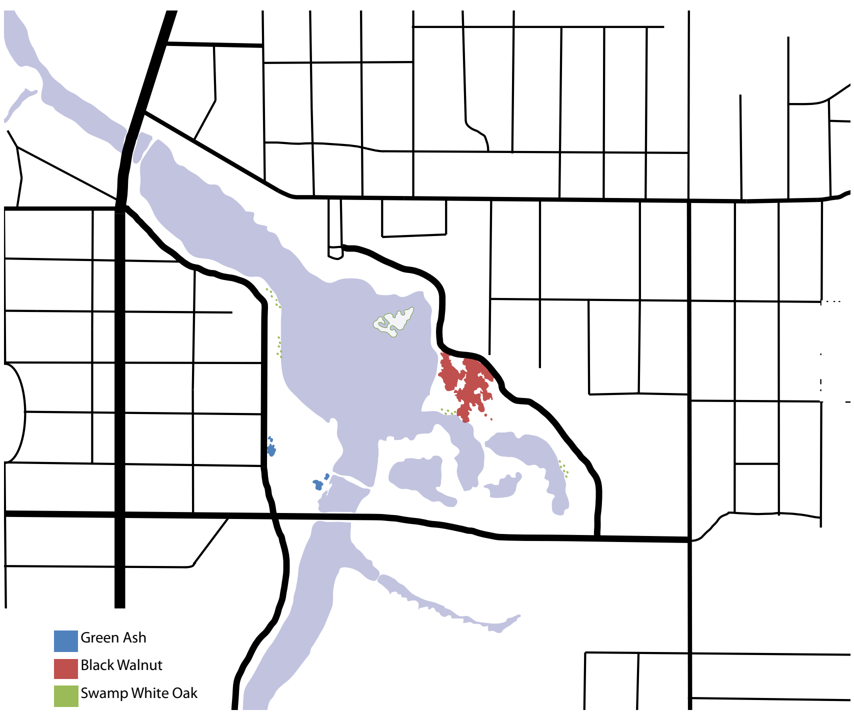
Amur maple and mountain-ash are other tree species suitable for planting with spring and fall landscape attributes.

Tree Inventory: Silver Lake Park



Eastern cottonwoods are the main tree species in low lying areas with ample moisture.

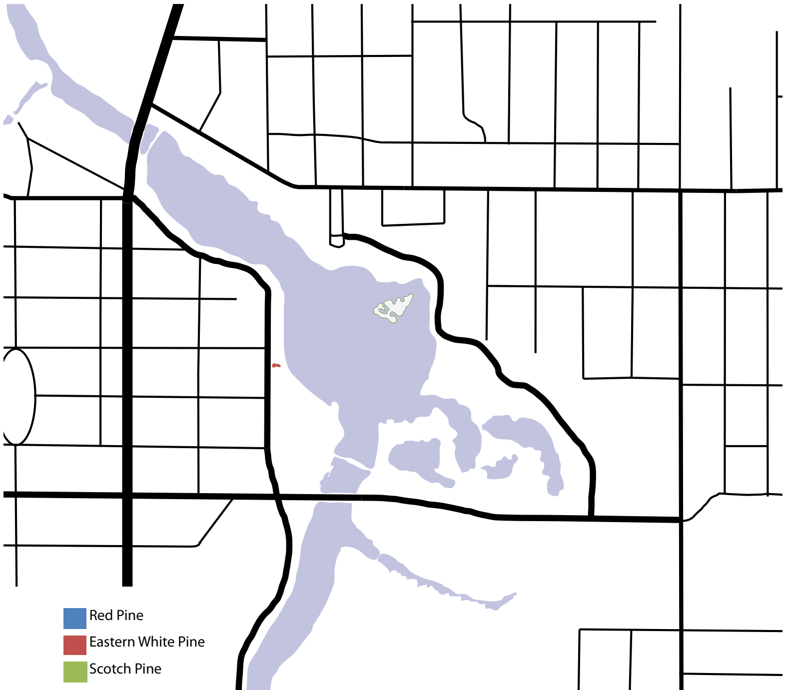
Northern catalpas merit planting in less exposed sites.



Black walnuts dominate the landscape by the east picnic shelter.

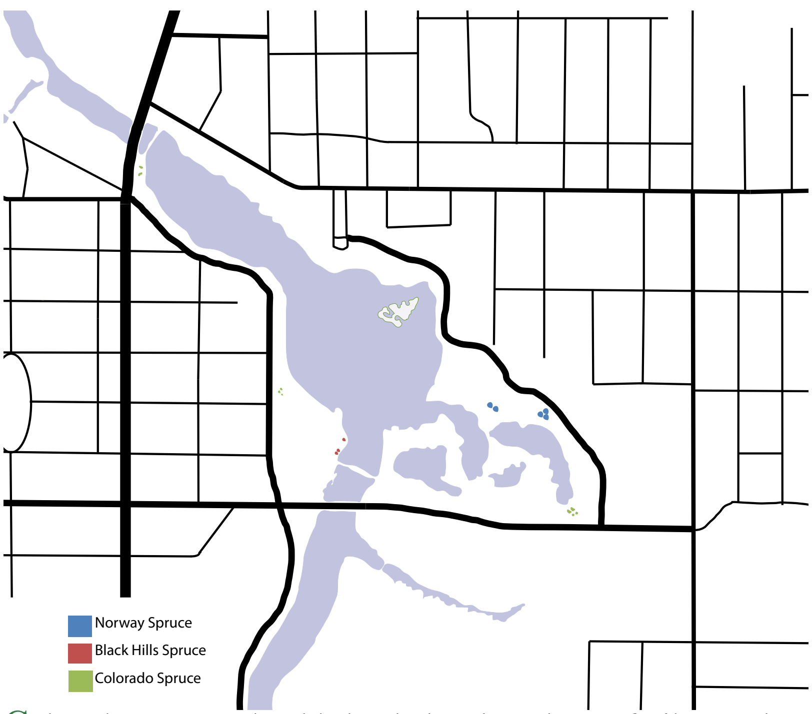
Green ash are likely to go into a 30 to 40 year disappearence similar to American elms in the 1950's and 1960's.

Tree Inventory: Silver Lake Park



Scotch and red pine should be considered in future plantings.

Eastern white pine is used cautiously in Minnesota due to white pine blister rust.



Colorado spruces should slowly be phased out of Silver Lake Park.

Colorado spruces cannot tolerate humid environments. Black Hills and Meyer Spruce are excellent replacements.

Tree Inventory: Silver Maple, Common Hackberry & American Elm

Silver Maple: *Acer saccharinum*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	44	17	$1.21	$0.13
6 inch	430	229	$11.64	$1.70
12 inch	1,237	679	$33.52	$5.00
24 inch	3,691	1,560	$100.04	$11.30
36 inch	6,857	2,562	$185.82	$18.20
48 inch	7,692	3,428	$208.44	$24.02

Common Hackberry: *Celtis occidentalis*

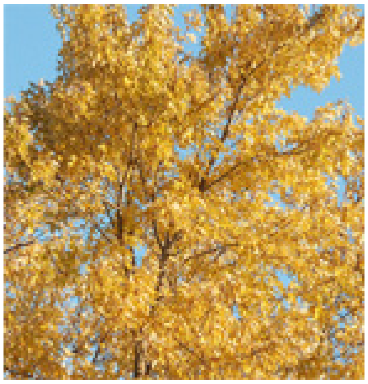
BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	12	7	$0.32	$0.05
6 inch	327	155	$8.86	$1.16
12 inch	1,022	463	$27.69	$3.43
24 inch	3,026	990	$81.99	$7.20
36 inch	5,739	1,425	$155.52	$10.07
48 inch	6,493	1,629	$175.96	$11.17

American Elm: *Ulmus americana*

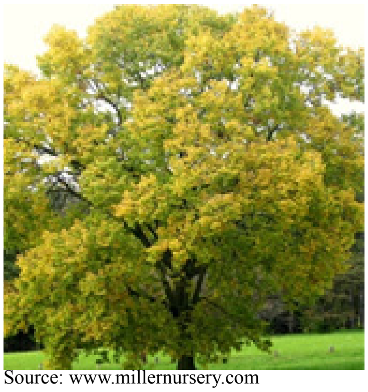
BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	2	6	$0.06	$0.04
6 inch	209	133	$5.67	$0.98
12 inch	912	443	$24.70	$3.25
24 inch	3,665	952	$99.33	$6.80
36 inch	4,551	1,430	$123.33	$9.84
48 inch	4,551	1,707	$123.33	$9.84

Information calculated from National Tree Benefit Calculator at www.treebenfits.com

Tree Inventory: Stormwater & Atmospheric Carbon Benefits


Source: www.flickr.com

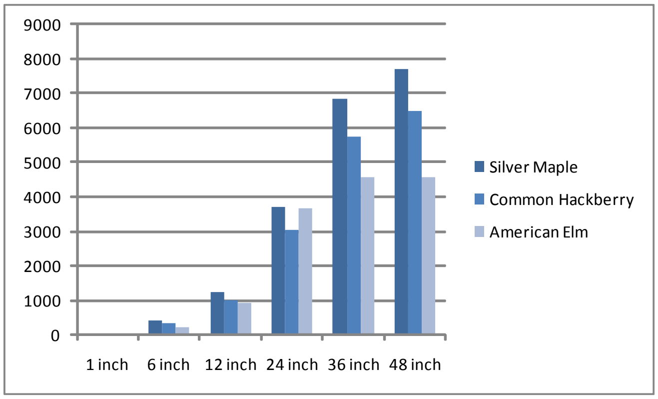
Silver Maple


Source: www.millernursery.com

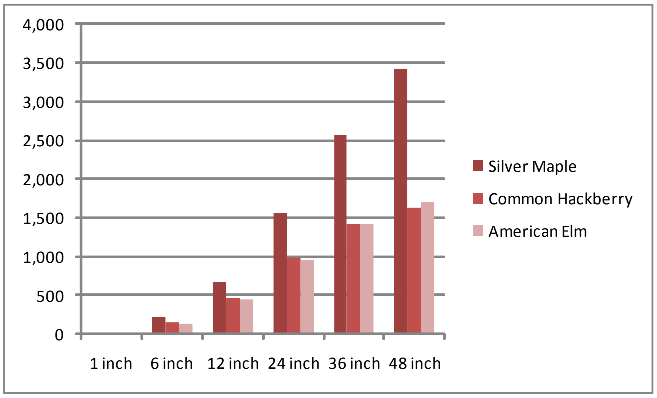
Common Hackberry

American Elm

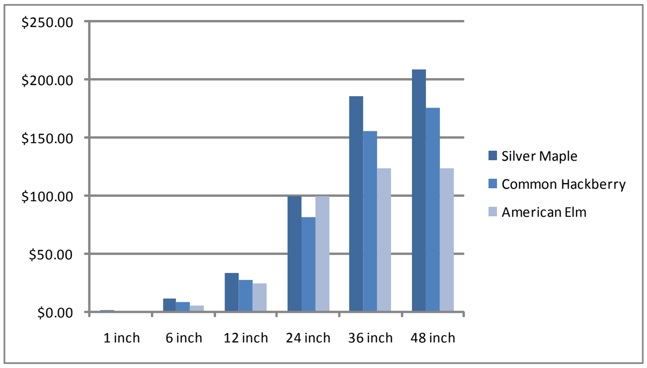
Stormwater Runoff in Gallons



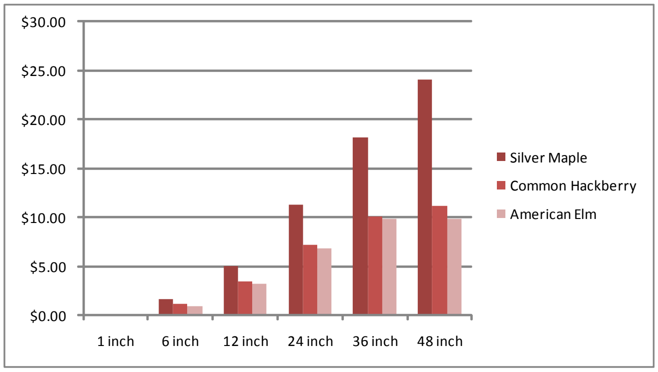
Atmospheric Carbon Storage in Pounds



Stormwater Savings



Atmospheric Carbon Savings



Tree Inventory: Thornless Honey-locust, Kentucky Coffeetree & Bur Oak

Thornless Honey-locust: *Gleditsia tricanthos var. inermis*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	13	14	$0.35	$0.11
6 inch	330	227	$8.93	$1.69
12 inch	1,092	681	$29.59	$5.04
24 inch	3,795	1,772	$102.84	$12.95
36 inch	4,685	613	$126.96	$4.16
48 inch	n/a	n/a	n/a	n/a

Kentucky Coffeetree: *Gymnocladus dioica*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	12	5	$0.32	$0.03
6 inch	317	204	$8.59	$1.51
12 inch	1,037	602	$28.09	$4.43
24 inch	3,267	1,252	$88.53	$8.96
36 inch	6,365	1,625	$172.48	$11.01
48 inch	7,239	1,292	$196.17	$7.60

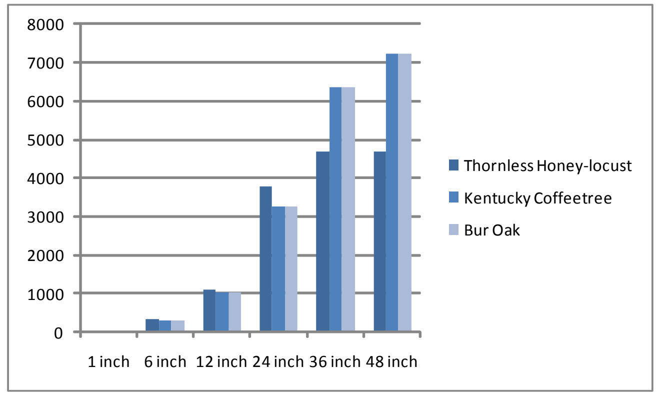
Bur Oak: *Quercus macrocarpa*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	12	5	$0.32	$0.03
6 inch	317	204	$8.59	$1.51
12 inch	1,037	602	$28.09	$4.43
24 inch	3,267	1,252	$88.53	$8.96
36 inch	6,365	1,625	$172.48	$11.01
48 inch	7,239	1,292	$196.17	$7.60

Information calculated from National Tree Benefit Calculator at www.treebenfits.com

Tree Inventory: Stormwater & Atmospheric Carbon Benefits

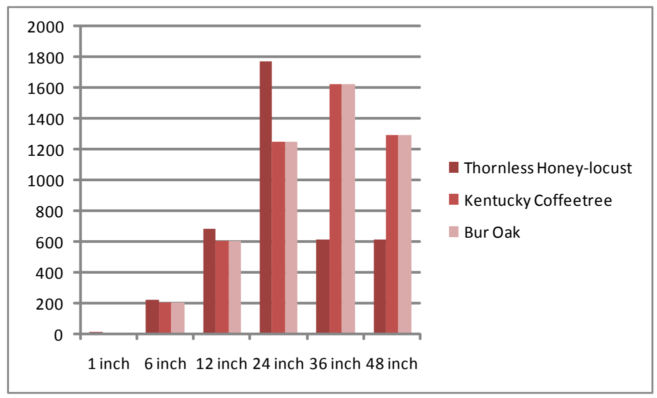
Stormwater Runoff in Gallons



Source: Jake Berg

Thornless Honey-locust

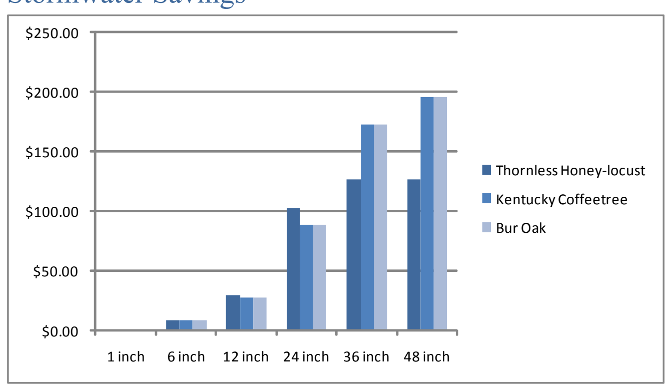
Atmospheric Carbon Storage in Pounds



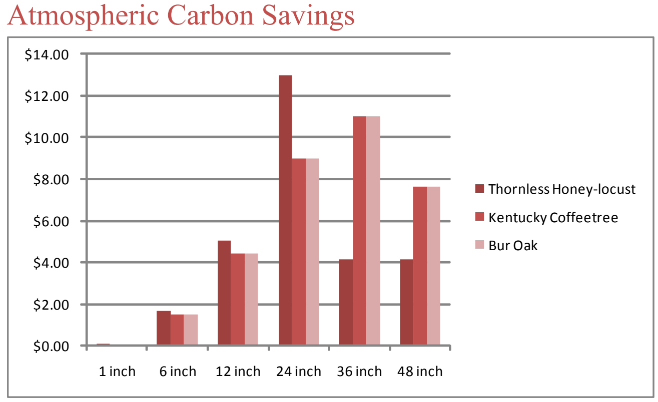
Source: www.flickr.com

Kentucky Coffeetree

Stormwater Savings



Atmospheric Carbon Savings



Source: Jake Berg

Bur Oak

Tree Inventory: Paper Birch, Northern Pin Oak & American Linden

Paper Birch: *Betula papyrifera*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	12	5	$0.32	$0.03
6 inch	317	204	$8.59	$1.51
12 inch	1,037	602	$28.09	$4.43
24 inch	3,267	1,252	$88.53	$8.96
36 inch	6,365	1,625	$172.48	$11.01
48 inch	7,239	1,260	$196.17	$7.66

Northern Pin Oak: *Quercus ellipsoidalis*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	8	8	$0.22	$0.06
6 inch	304	240	$8.23	$1.78
12 inch	998	589	$27.63	$4.33
24 inch	3,122	907	$84.60	$6.40
36 inch	3,764	537	$84.60	$3.52
48 inch	3,764	537	$84.60	$3.52

American Linden: *Tilia americana*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	5	5	$0.15	$0.04
6 inch	236	144	$6.41	$1.06
12 inch	831	471	$22.52	$3.45
24 inch	2,709	1,213	$73.41	$8.68
36 inch	5,353	2,282	$145.06	$15.99
48 inch	7,754	3,307	$210.14	$22.88

Information calculated from National Tree Benefit Calculator at www.treebenfits.com

Tree Inventory: Stormwater & Atmospheric Carbon Benefits

Source: Jake Berg

Paper Birch

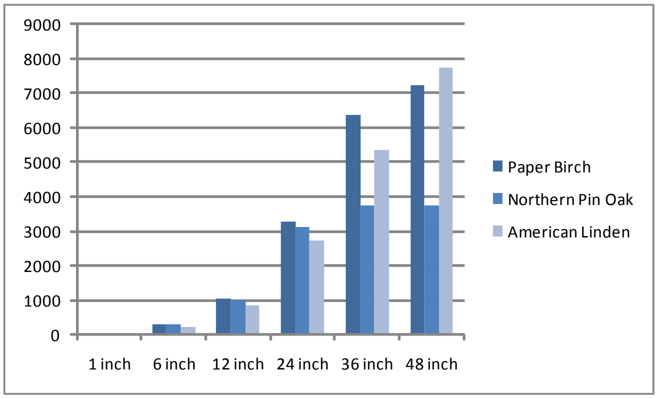
Source: Jake Berg

Northern Pin Oak

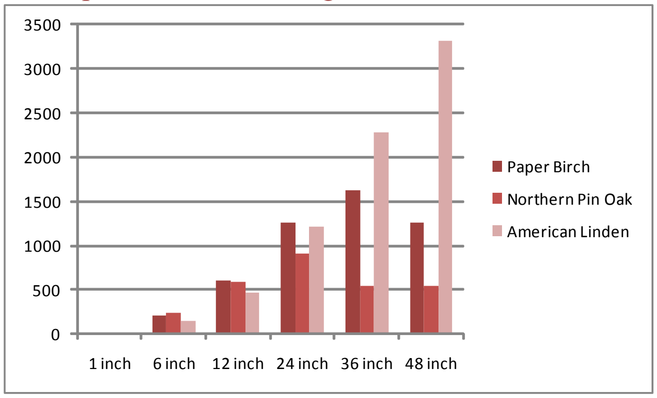
Source: www.life.illinois.edu

American Linden

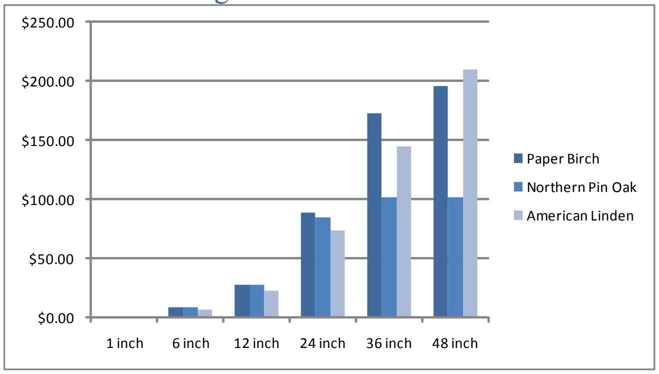
Stormwater Runoff in Gallons



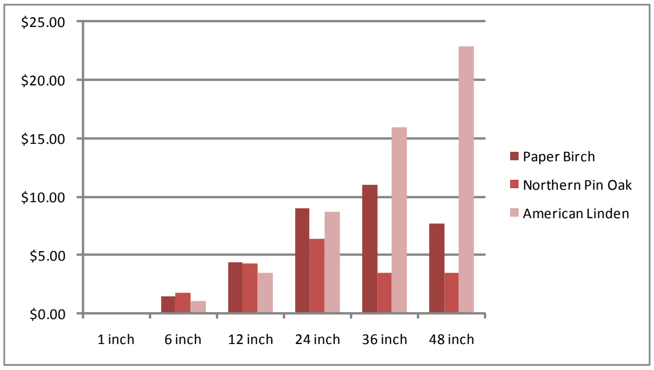
Atmospheric Carbon Storage in Pounds



Stormwater Savings



Atmospheric Carbon Savings



Tree Inventory: Norway Maple, Red Maple & Sugar Maple

Norway Maple: *Acer platanoides*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	8	8	$0.22	$0.06
6 inch	304	240	$8.23	$1.78
12 inch	998	589	$27.03	$4.33
24 inch	3,122	907	$84.60	$6.40
36 inch	3,764	537	$102.01	$3.52
48 inch	n/a	n/a	n/a	n/a

Red Maple: *Acer rubrum*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	8	6	$0.21	$0.05
6 inch	306	183	$8.13	$1.35
12 inch	1,115	631	$30.20	$4.65
24 inch	2,867	937	$77.67	$6.74
36 inch	n/a	n/a	n/a	n/a
48 inch	n/a	n/a	n/a	n/a

Sugar Maple: *Acer saccharum*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	7	17	$0.20	$0.13
6 inch	276	182	$7.47	$1.35
12 inch	957	514	$25.93	$3.77
24 inch	3,131	1,123	$84.85	$8.02
36 inch	6,206	1,796	$168.19	$12.45
48 inch	7,083	2,328	$191.94	$15.77

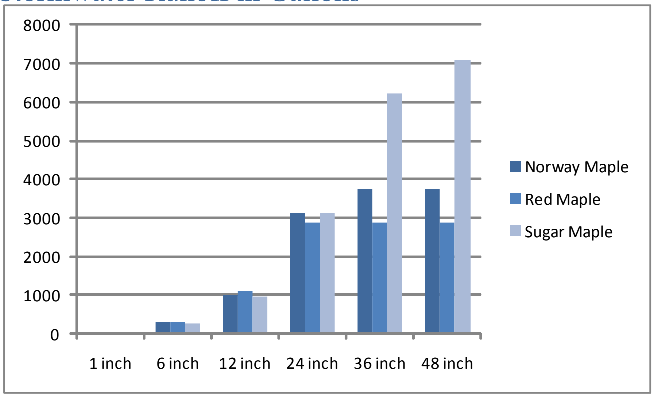
Information calculated from National Tree Benefit Calculator at www.treebenfits.com

Tree Inventory: Stormwater & Atmospheric Carbon Benefits

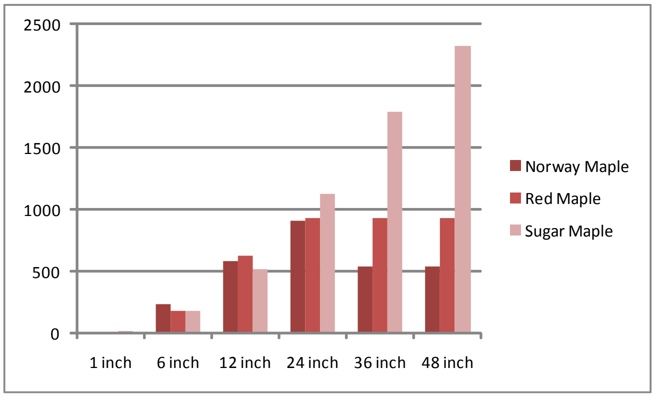
Source: Jake Berg

Norway Maple

Stormwater Runoff in Gallons



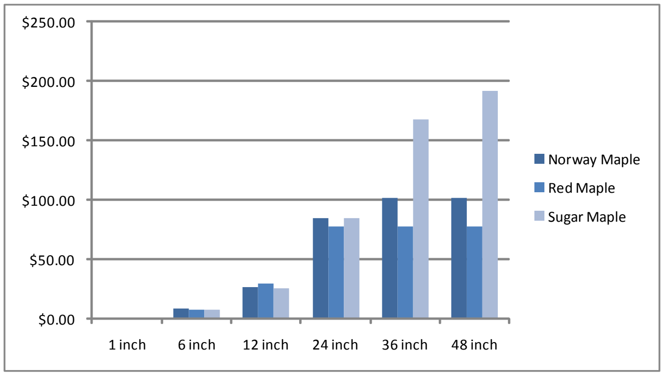
Atmospheric Carbon Storage in Pounds



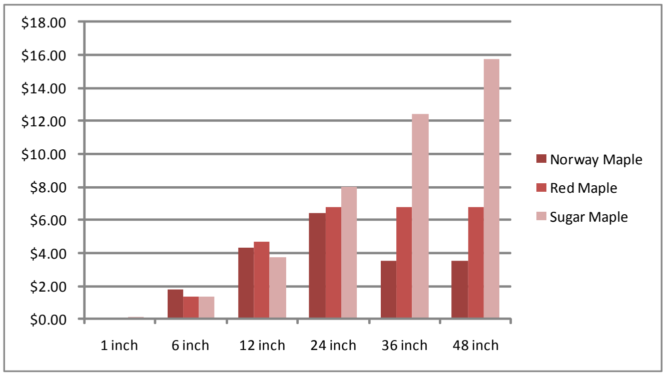
Source: www.scottarboretum.org

Red Maple

Stormwater Savings



Atmospheric Carbon Savings



Source: Jake Berg

Sugar Maple

Tree Inventory: Ironwood, Amur Corktree & Quaking Aspen

Ironwood: *Ostrya virginiana*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	5	10	$0.13	$0.07
6 inch	134	129	$3.63	$0.95
12 inch	466	406	$12.62	$2.97
24 inch	1,174	573	$31.82	$4.05
36 inch	1,174	334	$31.82	$2.26
48 inch	n/a	n/a	n/a	n/a

Amur Corktree: *Phellodendron amurense*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	8	8	$0.22	$0.06
6 inch	304	240	$8.23	$1.78
12 inch	998	589	$27.03	$4.33
24 inch	3,122	907	$84.60	$6.40
36 inch	3,764	537	$102.01	$4.90
48 inch	n/a	n/a	n/a	n/a

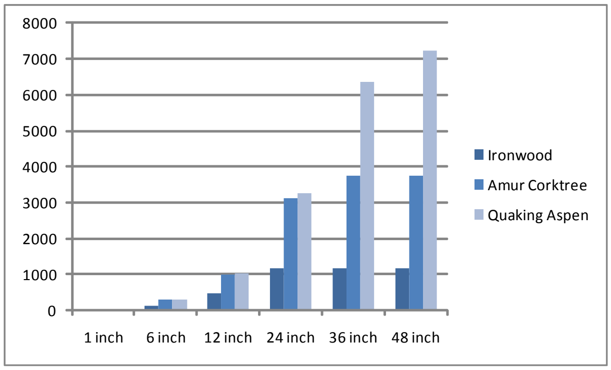
Quaking Aspen: *Populus tremuloides*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	12	5	$0.32	$0.03
6 inch	317	204	$8.59	$1.51
12 inch	1,037	602	$28.09	$4.43
24 inch	3,267	1,252	$88.53	$8.96
36 inch	6,365	1,625	$172.48	$11.01
48 inch	7,239	1,290	$196.17	$7.66

Information calculated from National Tree Benefit Calculator at www.treebenfits.com

Tree Inventory: Norway Maple, Red Maple & Sugar Maple

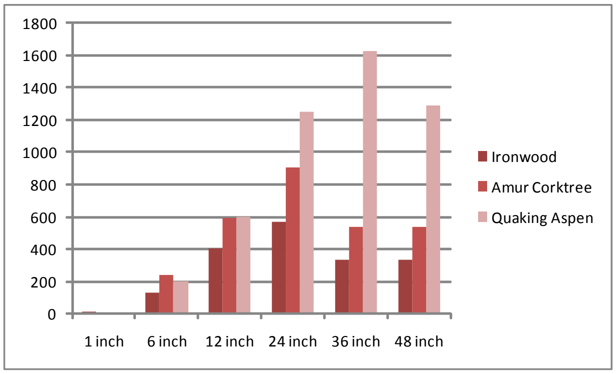
Stormwater Runoff in Gallons



Source: www.rainkc.com

Ironwood

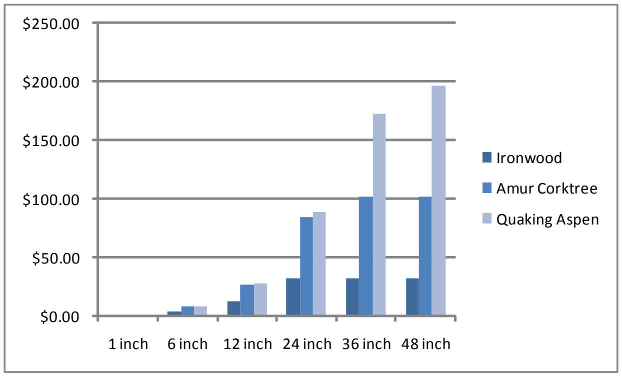
Atmospheric Carbon Storage in Pounds



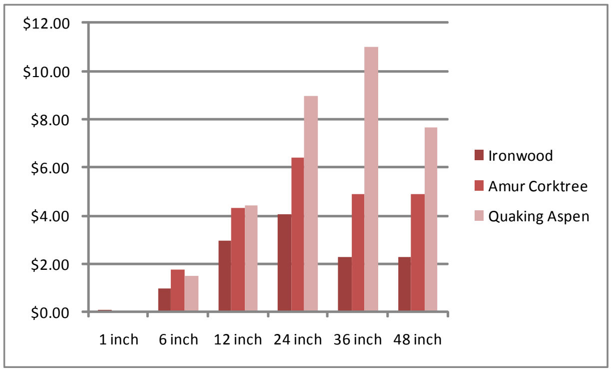
Source: www.jfrankschmidt.com

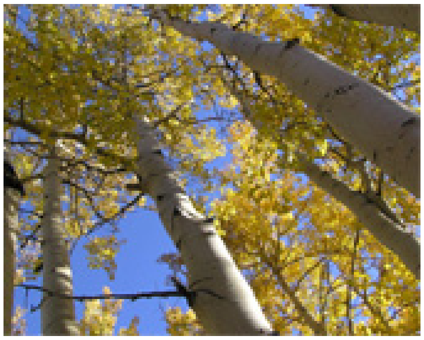
Amur Corktree

Stormwater Savings



Atmospheric Carbon Savings





Source: www.plantcare.com

Quaking Aspen

Tree Inventory: Manchurian Alder, River Birch & Ginkgo

Manchurian Alder: *Alnus hirsuta*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	8	8	$0.22	$0.06
6 inch	304	240	$8.23	$1.78
12 inch	998	589	$27.03	$4.33
24 inch	3,122	907	$84.60	$6.40
36 inch	3,764	537	$102.01	$3.52
48 inch	n/a	n/a	n/a	n/a

River Birch: *Betula nigra*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	8	8	$0.22	$0.06
6 inch	304	240	$8.23	$1.78
12 inch	998	589	$27.03	$4.33
24 inch	3,122	907	$84.60	$6.40
36 inch	3,764	537	$102	$3.52
48 inch	n/a	n/a	n/a	n/a

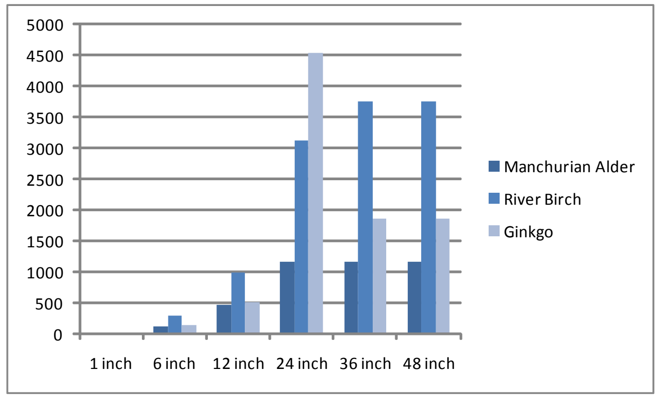
Ginkgo: *Ginkgo biloba*

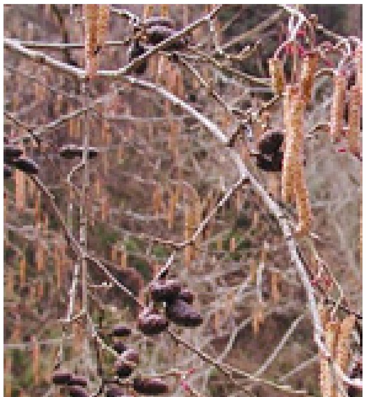
BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	5	4	$0.13	$0.03
6 inch	155	90	$4.20	$0.67
12 inch	510	294	$13.81	$2.16
24 inch	1,549	628	$41.96	$4.50
36 inch	1,857	395	$50.33	$2.68
48 inch	n/a	n/a	n/a	n/a

Information calculated from National Tree Benefit Calculator at www.treebenfits.com

Tree Inventory: Manchurian Alder, River Birch & Ginkgo

Stormwater Runoff in Gallons

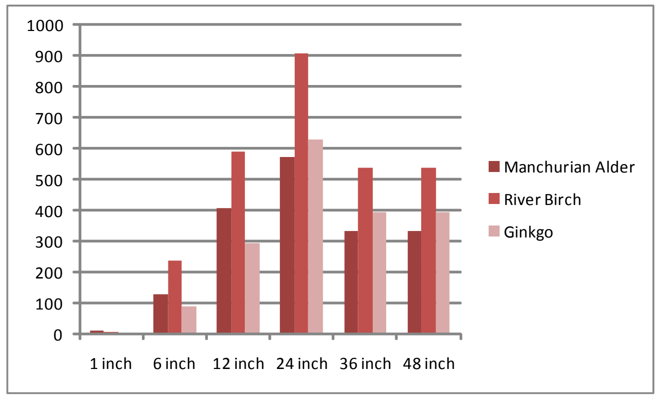


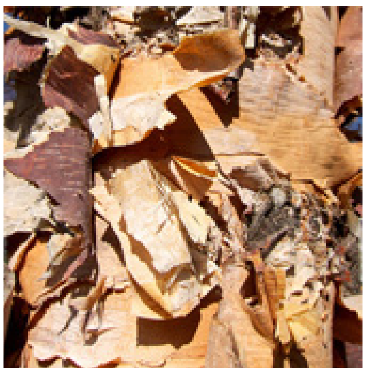


Source: www.mitomori.co.jp

Manchurian Alder

Atmospheric Carbon Storage in Pounds

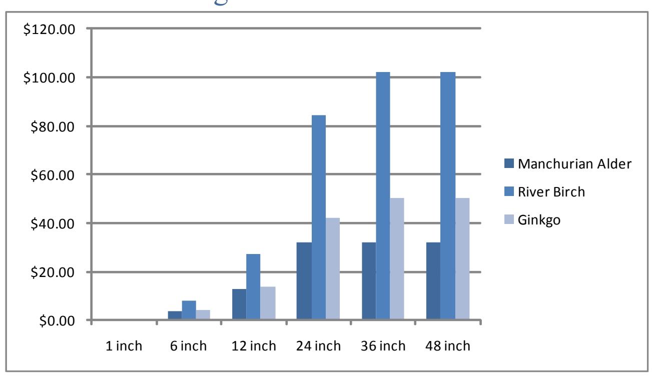




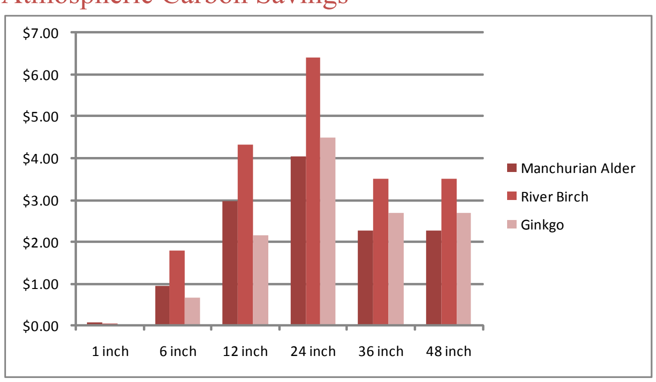
Source: www.flickr.com

River Birch

Stormwater Savings



Atmospheric Carbon Savings



Source: www.flickr.com

Ginkgo

Tree Inventory: Cucumbertree Magnolia, Callery Pear & Japanese Tree Lilac

Cucumbertree Magnolia: *Magnolia acuminata*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	8	8	$0.22	$0.06
6 inch	304	240	$8.23	$1.78
12 inch	998	589	$27.03	$4.33
24 inch	3,122	907	$84.60	$6.40
36 inch	3,764	537	$102.01	$3.52
48 inch	n/a	n/a	n/a	n/a

Callery Pear: *Pyrus calleryana*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	8	8	$0.22	$0.06
6 inch	304	240	$8.23	$1.78
12 inch	998	589	$27.03	$4.33
24 inch	3,122	907	$84.60	$6.40
36 inch	3,764	537	$102.01	$3.52
48 inch	n/a	n/a	n/a	n/a

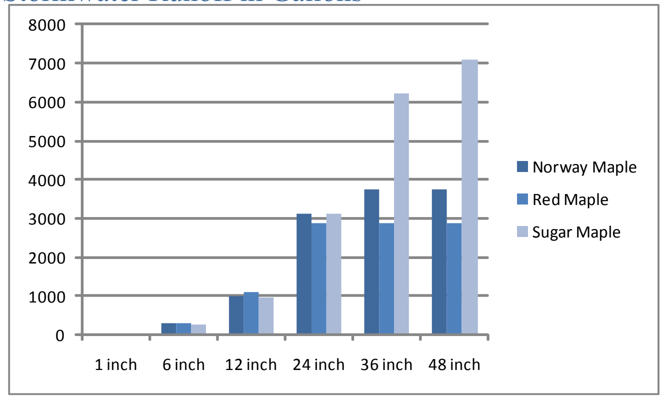
Japanese Tree Lilac: *Syringa reticulata*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	7	17	$0.20	$0.13
6 inch	276	182	$7.47	$1.35
12 inch	957	514	$25.93	$3.77
24 inch	3,131	1,123	$84.85	$8.02
36 inch	6,206	1,796	$168.19	$12.45
48 inch	7,083	2,328	$191.94	$15.77

Information calculated from National Tree Benefit Calculator at www.treebenfits.com

Tree Inventory: Norway Maple, Red Maple & Sugar Maple

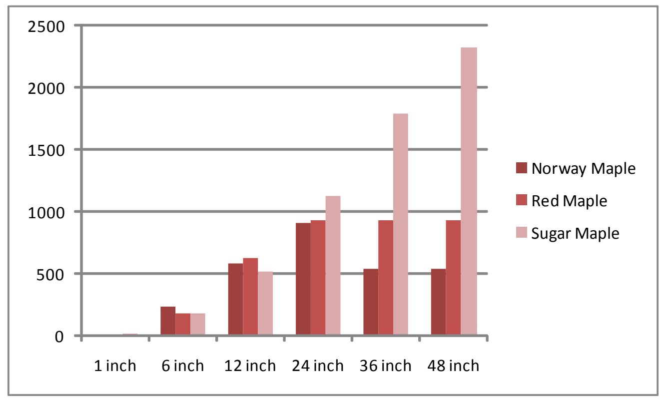
Stormwater Runoff in Gallons

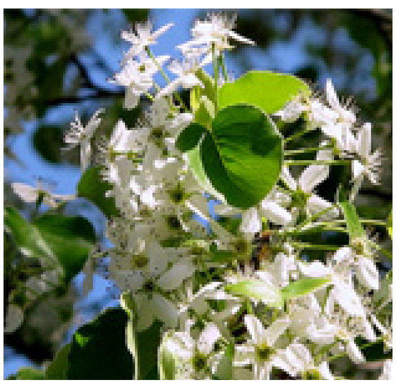


Source: www.flickr.com

Cucumbertree Magnolia

Atmospheric Carbon Storage in Pounds

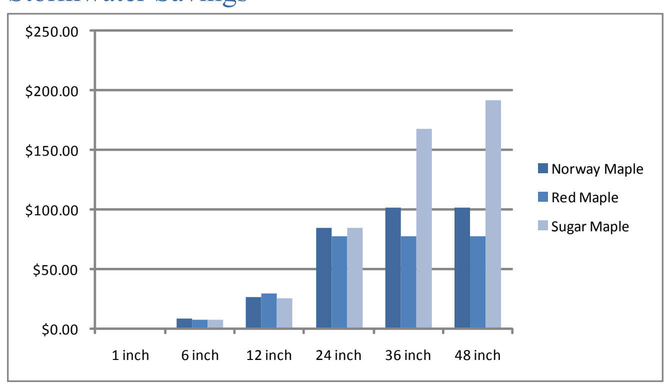




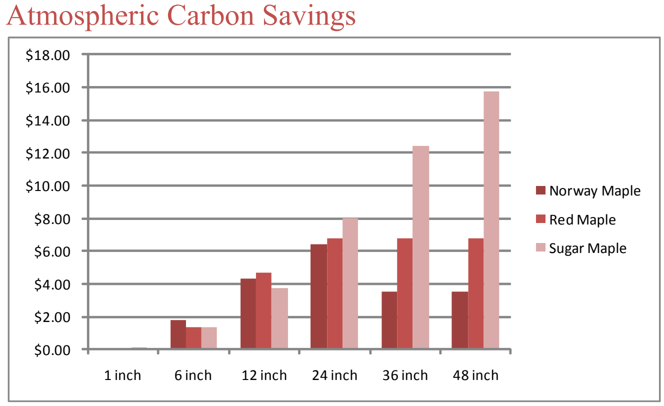
Source: www.flickr.com

Callery Pear

Stormwater Savings



Atmospheric Carbon Savings



Source: www.flickr.com

Japanese Tree Lilac

Tree Inventory: Amur Maple, Crabapple & Mountain-ash

Amur Maple: *Acer ginnala*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	12	5	$0.32	$0.03
6 inch	317	204	$8.59	$1.51
12 inch	1,037	602	$28.09	$4.43
24 inch	3,267	1,252	$88.53	$8.96
36 inch	6,365	1,625	$172.48	$11.01
48 inch	7,239	1,290	n/a	n/a

Crabapple: *Malus hybrids*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	12	5	$0.13	$0.07
6 inch	317	204	$3.63	$0.95
12 inch	1,037	602	$12.62	$2.97
24 inch	3,267	1,252	$31.82	$4.05
36 inch	6,365	1,625	$31.82	$2.26
48 inch	7,239	1,290	$31.82	$2.26

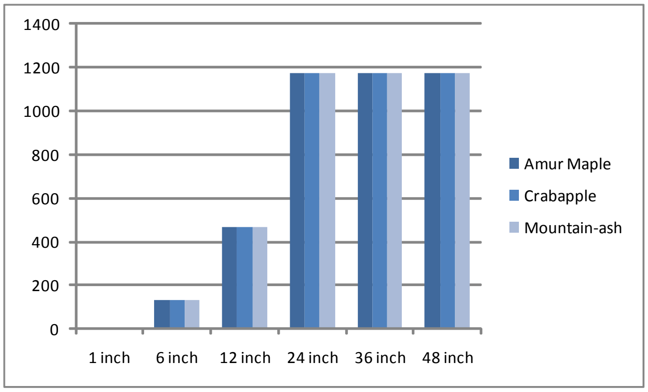
Mountain-ash: *Sorbus alnifolia*

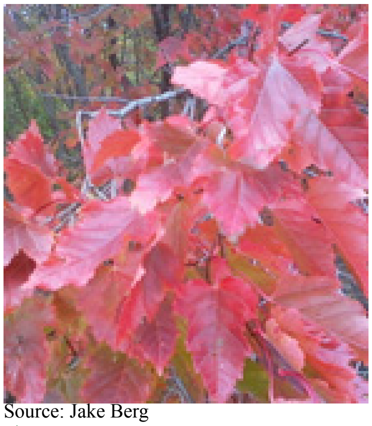
BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	5	10	$0.13	$0.07
6 inch	134	129	$3.63	$0.95
12 inch	466	406	$12.62	$2.97
24 inch	1,174	573	$31.82	$4.05
36 inch	1,174	334	$31.82	$2.26
48 inch	1,174	334	$31.82	$2.26

Information calculated from National Tree Benefit Calculator at www.treebenfits.com

Tree Inventory: Amur Maple, Crabapple & Mountain-ash

Stormwater Runoff in Gallons

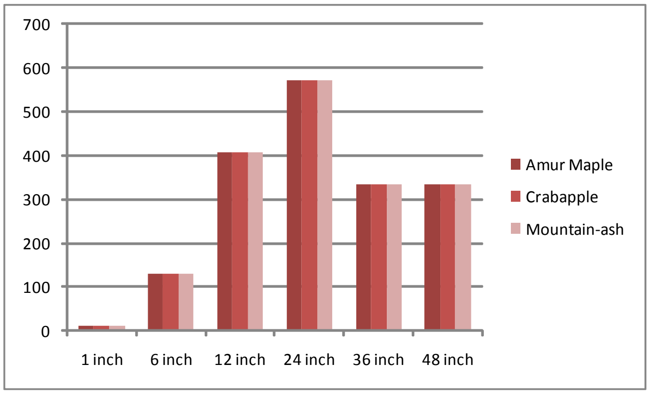




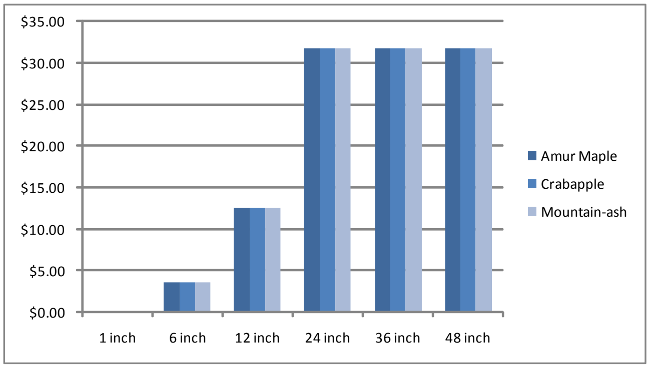
Source: Jake Berg

Amur Maple

Atmospheric Carbon Storage in Pounds



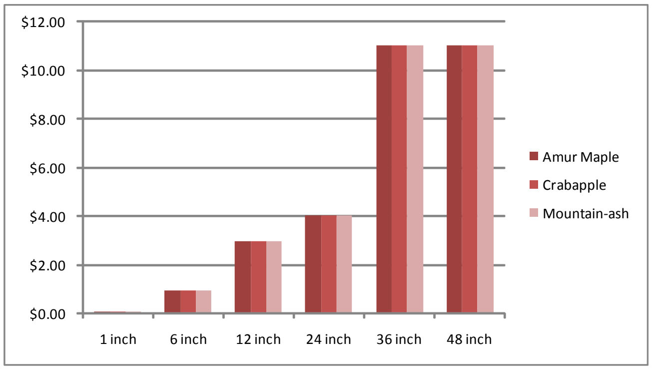
Stormwater Savings



Source: www.flickr.com

Crabapple

Atmospheric Carbon Savings



Source: www.flickr.com

Mountain-ash

Tree Inventory: Northern Catalpa, Eastern Cottonwood & Littleleaf Linden

Northern Catalpa: *Catalpa speciosa*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	12	5	$0.32	$0.03
6 inch	317	204	$8.59	$1.51
12 inch	1,037	602	$28.09	$4.43
24 inch	3,267	1,252	$88.53	$8.96
36 inch	6,365	1,625	$172.48	$11.01
48 inch	n/a	n/a	n/a	n/a

Eastern Cottonwood: *Populus deltoides*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	12	5	$0.32	$0.03
6 inch	317	204	$8.59	$1.51
12 inch	1,037	602	$28.09	$4.43
24 inch	3,267	1,252	$88.53	$8.96
36 inch	6,365	1,625	$172.48	$11.01
48 inch	7,239	1,290	$196.17	$7.66

Littleleaf Linden: *Tilia cordata*

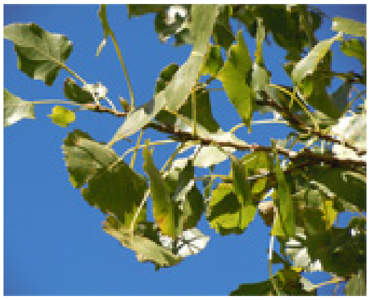
BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	5	15	$0.15	$0.04
6 inch	216	187	$6.41	$1.06
12 inch	860	603	$22.52	$3.45
24 inch	3,055	1,380	$73.41	$8.68
36 inch	3,744	477	$145.06	$15.99
48 inch	3,744	477	$210.14	$22.88

Information calculated from National Tree Benefit Calculator at www.treebenfits.com

Tree Inventory: Northern Catalpa, Cottonwood & Littleleaf Linden


Source: www.flickr.com

Northern Catalpa

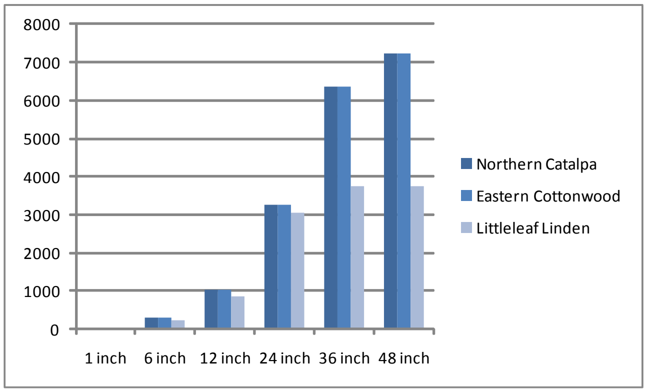

Source: www.flickr.com

Eastern Cottonwood

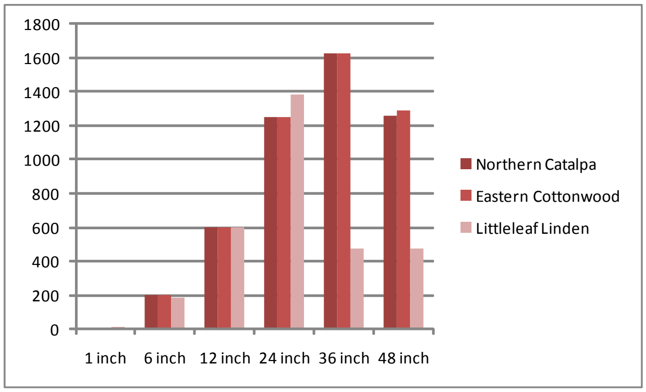

Source: www.flickr.com

Littleleaf Linden

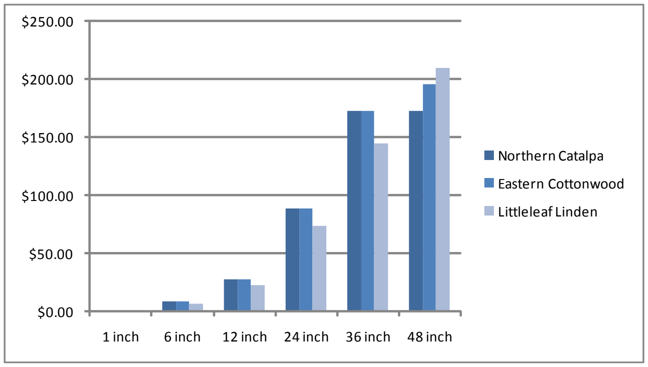
Stormwater Runoff in Gallons



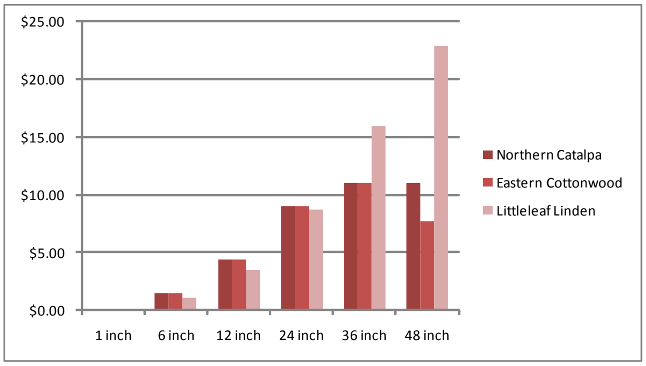
Atmospheric Carbon Storage in Pounds



Stormwater Savings



Atmospheric Carbon Savings



Tree Inventory: Red, Eastern White & Scotch Pines

Red Pine *Pinus resinosa*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	32	6	$0.88	$0.05
6 inch	340	86	$9.22	$0.64
12 inch	1,067	239	$28.92	$1.77
24 inch	3,787	499	$102.62	$3.55
36 inch	4,605	310	$124.79	$2.06
48 inch	n/a	n/a	n/a	n/a

Eastern White Pine: *Pinus strobus*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	32	6	$0.88	$0.05
6 inch	340	86	$9.22	$0.64
12 inch	1,067	239	$28.92	$1.77
24 inch	3,787	499	$102.62	$3.55
36 inch	4,605	310	$124.79	$2.06
48 inch	n/a	n/a	n/a	n/a

Scotch Pine: *Pinus sylvestris*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	32	6	$0.88	$0.05
6 inch	340	86	$9.22	$0.64
12 inch	1,067	239	$28.92	$1.77
24 inch	3,787	499	$102.62	$3.55
36 inch	4,605	310	$124.79	$2.06
48 inch	n/a	n/a	n/a	n/a

Information calculated from National Tree Benefit Calculator at www.treebenfits.com

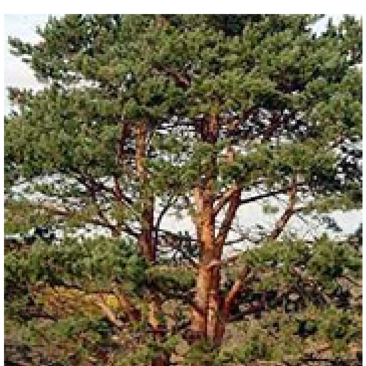
Tree Inventory: Red, Eastern White & Scotch Pines


Source: www.yuletreesfarm.com

Red Pine

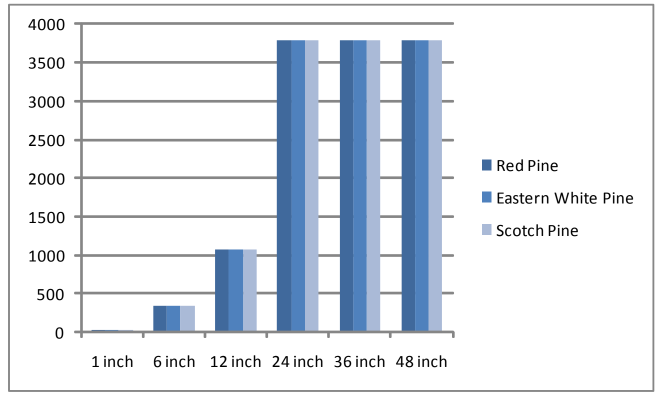

Source: www.talltreesgroup.com

Eastern White Pine

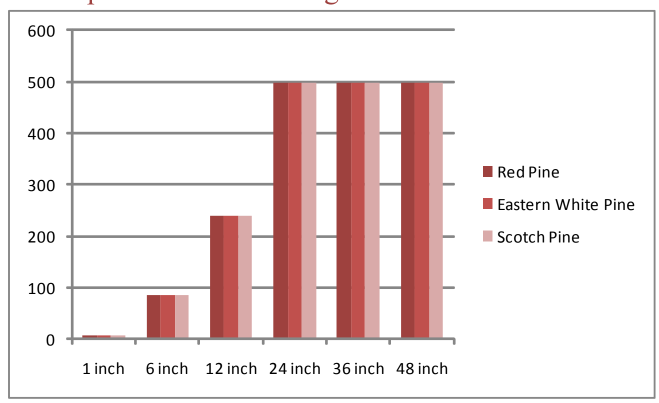

Source: www.wisplants.uwsp.edu

Scotch Pine

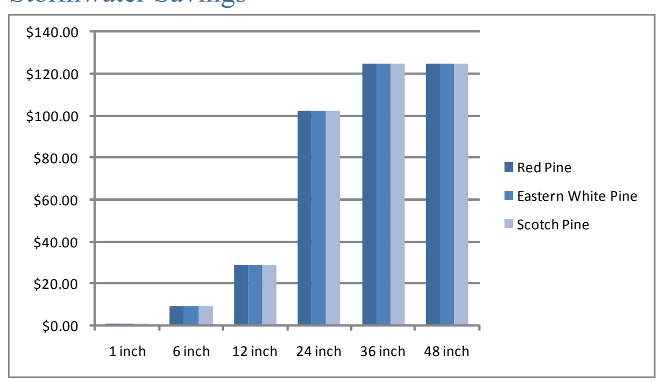
Stormwater Runoff in Gallons



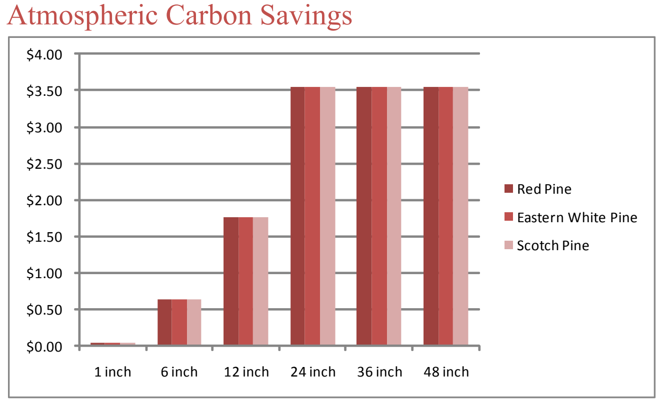
Atmospheric Carbon Storage in Pounds



Stormwater Savings



Atmospheric Carbon Savings



Tree Inventory: Norway, Black Hills & Colorado Spruces

Norway Spruce: *Picea abies*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	32	6	$0.88	$0.05
6 inch	340	86	$9.22	$0.64
12 inch	1,067	239	$28.92	$1.77
24 inch	3,787	499	$102.62	$3.55
36 inch	4,605	310	$124.79	$2.06
48 inch	n/a	n/a	n/a	n/a

Black Hills Spruce: *Pice glauca var. densata*

BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	32	6	$0.88	$0.05
6 inch	340	86	$9.22	$0.64
12 inch	1,067	239	$28.92	$1.77
24 inch	3,787	499	$102.62	$3.55
36 inch	4,605	310	$124.79	$2.06
48 inch	n/a	n/a	n/a	n/a

Colorado Spruce: *Picea pungens*

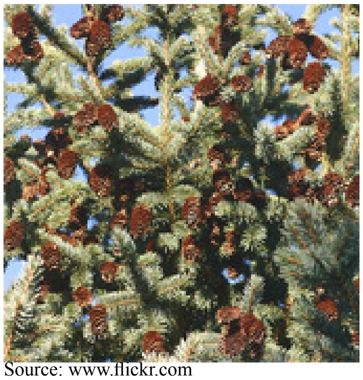
BDH @ 4.5 ft	Stormwater Runoff (Gallons)	Atmospheric Carbon Stored (lbs)	Stormwater Runoff Savings	Atmospheric Carbon Savings
1 inch	25	8	$0.69	$0.06
6 inch	423	88	$11.46	$0.66
12 inch	1,150	224	$31.16	$1.65
24 inch	2,618	423	$70.96	$3.04
36 inch	2,925	279	$79.26	$1.92
48 inch	n/a	n/a	n/a	n/a

Information calculated from National Tree Benefit Calculator at www.treebenfits.com

Tree Inventory: Norway, Black Hills & Colorado Spruces


Source: Jake Berg

Norway Spruce

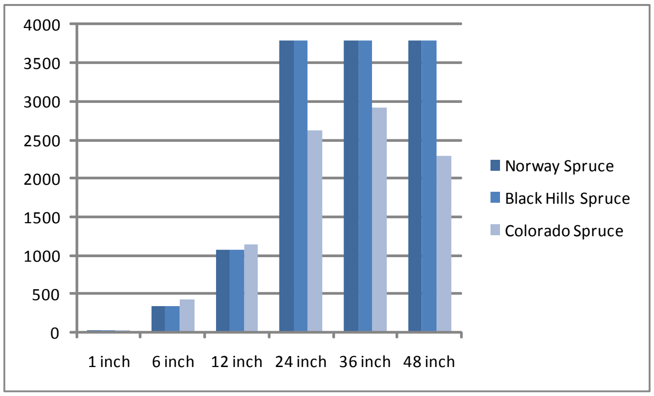

Source: www.flickr.com

Black Hills Spruce

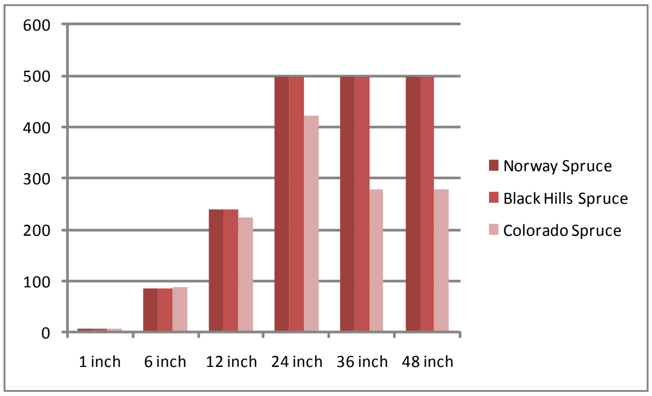

Source: www.flickr.com

Colorado Spruce

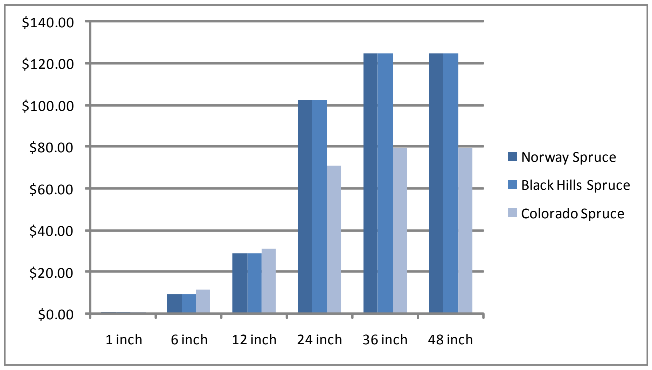
Stormwater Runoff in Gallons



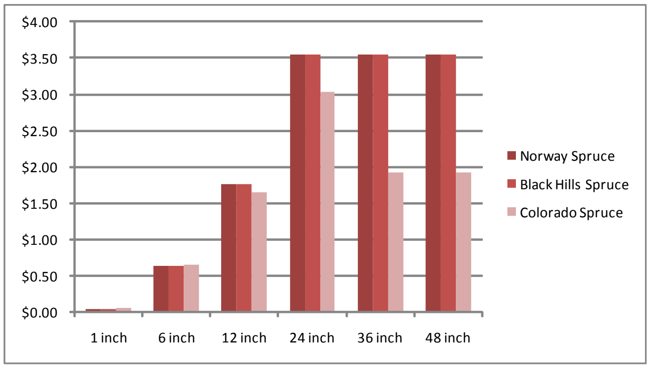
Atmospheric Carbon Storage in Pounds



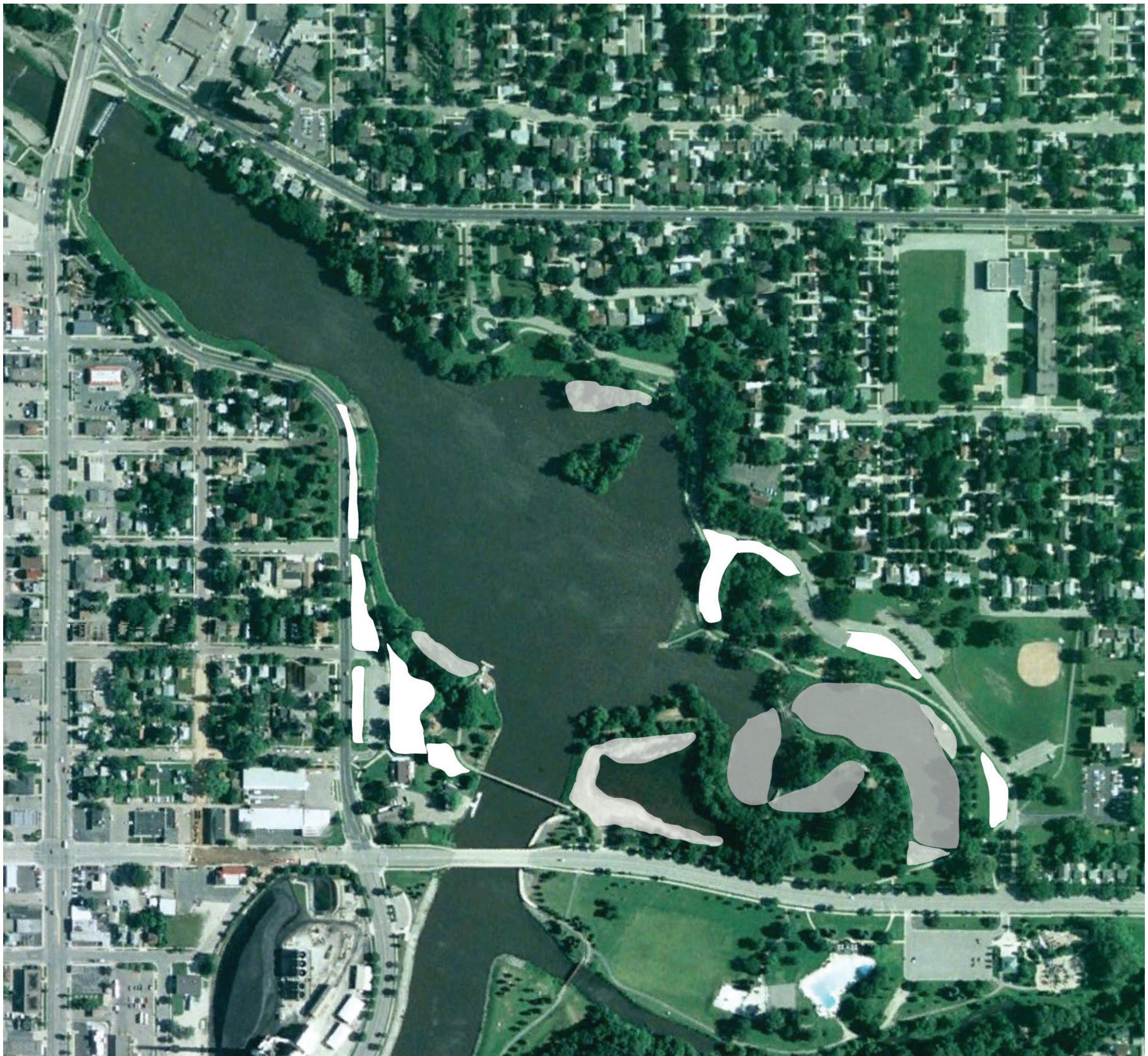
Stormwater Savings

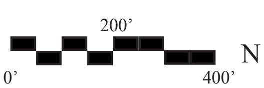


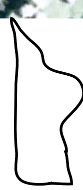
Atmospheric Carbon Savings



Geese Management & Proposed Plant Compositions:



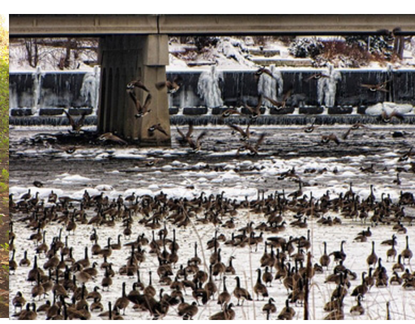




Proposed Plant Compositions

Proposed Constructed Marsh


Excessive Weed Growth:




Heated Reservoir: Winter

Existing Management Practices: Silver Lake Buffer

1.

Full sun plants growing under dense shade of existing *Acer saccharum*. The sugar maple limits the amount of sunlight for plants, thus, increases disease susceptibility.

2.

Powdry mildew develops on existing *Heliopsis helianthoides.* Buffer was seeded too dense, which increased humidity between plants. In return, high humidity promotes an ideal environment for disease.

3.

Poor long-term planning for plant compositions results in anaerobic soil conditions. Major constituents of the plant compositions need well drained soils. In August 2010, flash flooding illustrated areas of weakness with the Silver Lake buffer.

4.

Cypress mulch is piled 3 to 4 inches against base of *Acer saccharum* trunk. Mulch against a tree trunk leads to trunk rot due to consistently moist conditions.

Existing Management Practices: Inadequate Practices

Storm damage on an existing *Ulmus americana* needs to be removed immediately if it poses a public safety hazard.

Newly planted *Celtis occidentalis* and *Quercus bicolor* are planted too close together and near existing sidewalks. Current tree spacing is at 8 feet, when a minimum of 30 to 45 feet is ideal for large deciduous trees.

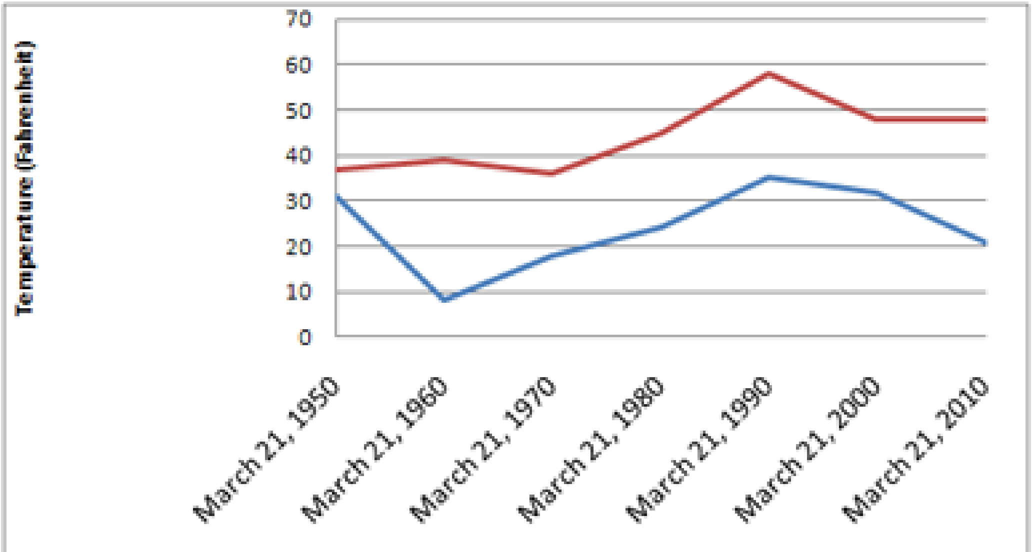
Asphalt sidewalks are placed too close to existing trees, which results in damages. Sidewalks should not be place underneath a tree's dripline.

Shallow roots of *Acer saccharinum* are exposed on 80+ year old trees. Mowers have been striking these surface roots, which can cause localized damage to the silver maples.

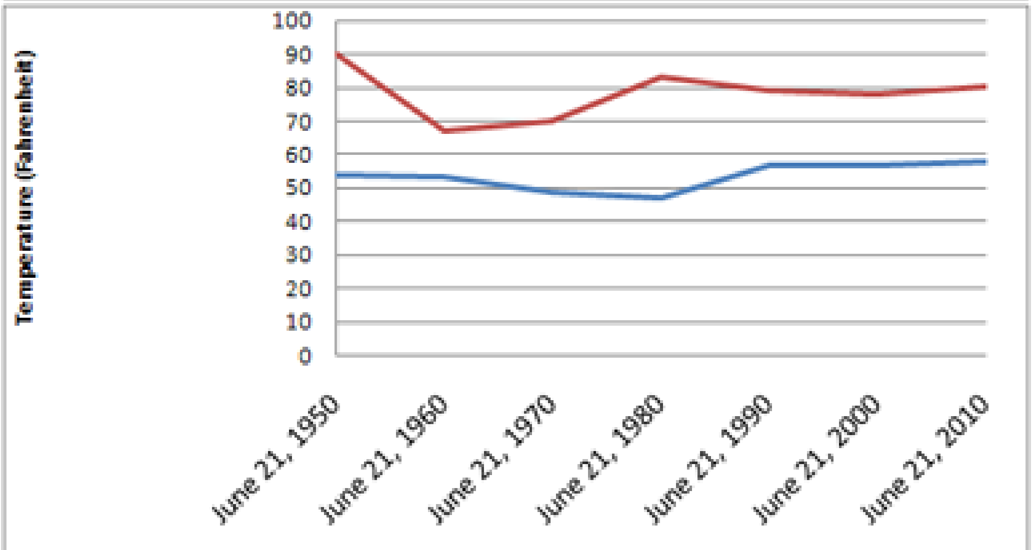
QUANTITATIVE CLIMATE ANALYSIS

Maximum & Minimum Temperatures

March 21 and June 21,1950 through 2010



	March 21, 1950	March 21, 1960	March 21, 1970	March 21, 1980	March 21, 1990	March 21, 2000	March 21, 2010
Maximum Temperature	37	39	36	45	57.9	48	48
Minimum Temperature	30.9	8.1	18	24.1	35.1	32	21



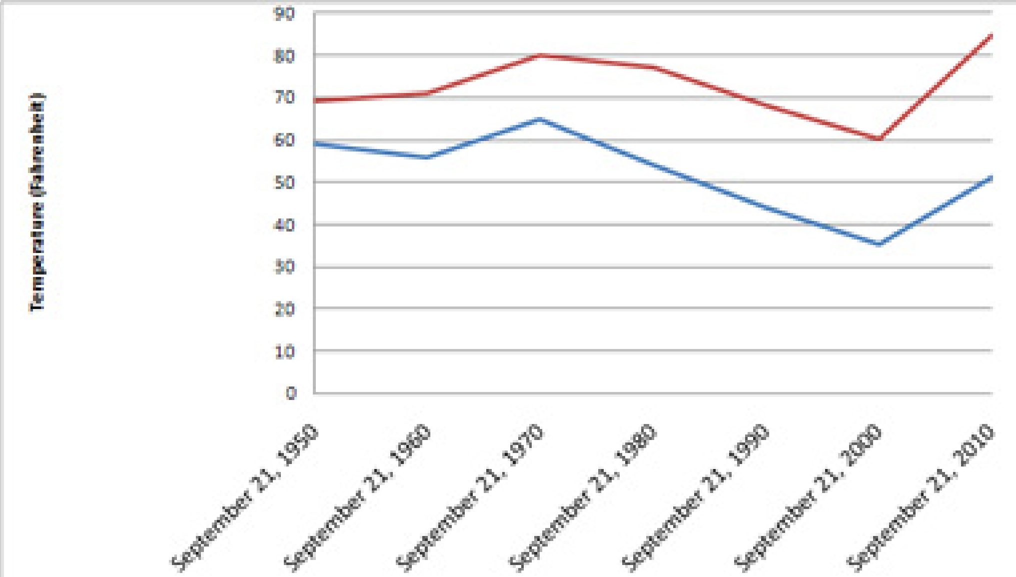
	June 21, 1950	June 21, 1960	June 21, 1970	June 21, 1980	June 21, 1990	June 21, 2000	June 21, 2010
Maximum Temperature	90	66.9	70	82.9	79	78.1	80.1
Minimum Temperature	54	53.1	48.9	46.9	57	57	57.9

Credit: Old Farmer's Almanac, data processed by Jacob Berg

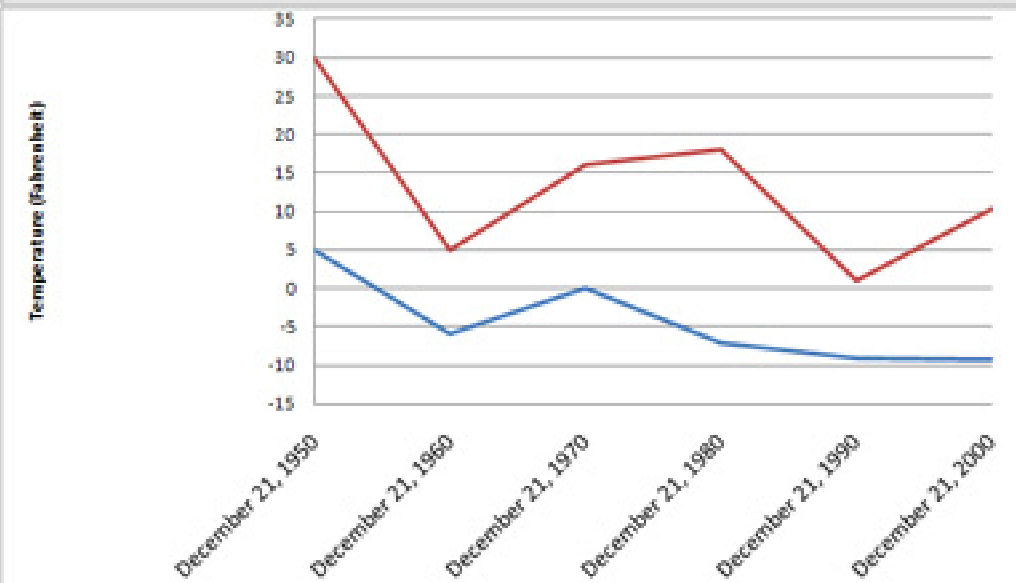
QUANTITATIVE CLIMATE ANALYSIS

Maximum & Minimum Temperatures

September 21 and December 21,1950 through 2010



	September 21, 1950	September 21, 1960	September 21, 1970	September 21, 1980	September 21, 1990	September 21, 2000	September 21, 2010
Maximum Temperature	69.1	71.1	80.1	77	68	60.1	84.9
Minimum Temperature	59	55.9	64.9	54	44.1	35.1	51.1



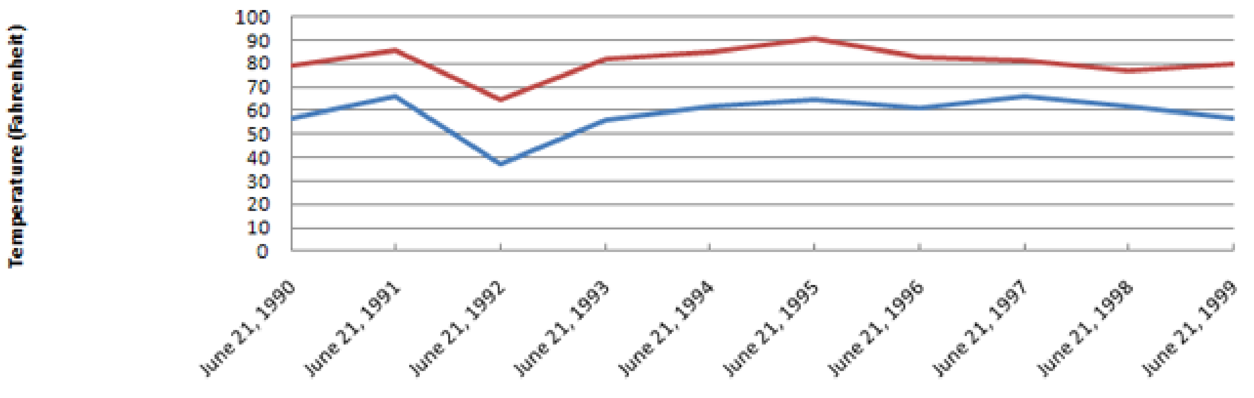
	December 21, 1950	December 21, 1960	December 21, 1970	December 21, 1980	December 21, 1990	December 21, 2000
Maximum Temperature	30	5	16	18	1	10.4
Minimum Temperature	5	-6	0	-7.1	-9.2	-9.4

Credit: Old Farmer's Almanac, data processed by Jacob Berg

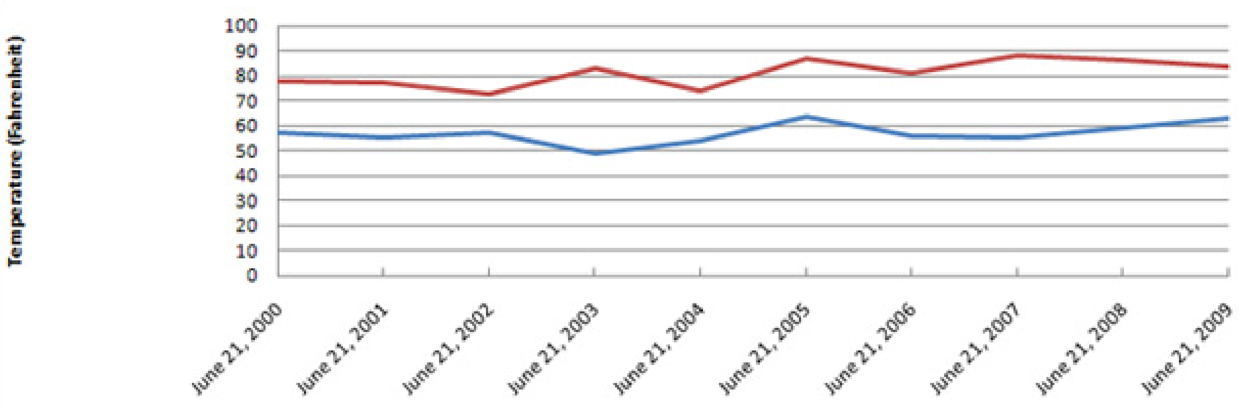
QUANTITATIVE CLIMATE ANALYSIS

Maximum & Minimum Temperatures

March 21, 1990 to March 21, 2009



	June 21, 1990	June 21, 1991	June 21, 1992	June 21, 1993	June 21, 1994	June 21, 1995	June 21, 1996	June 21, 1997	June 21, 1998	June 21, 1999
Maximum Temperature	79	86	64.9	82	84.9	91	82.9	81	77	80.1
Minimum Temperature	57	66	37	55.9	61.9	64.9	61	66	62.1	57



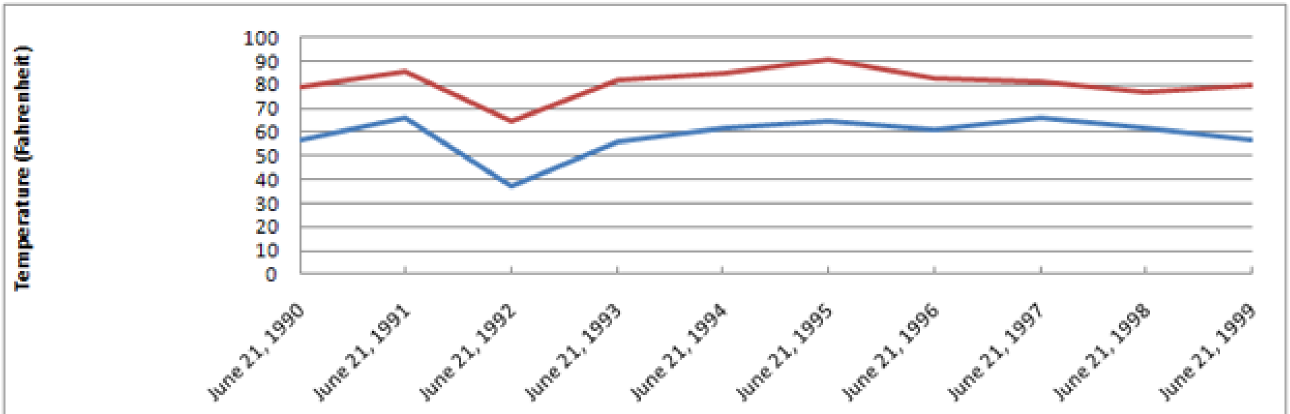
	June 21, 2000	June 21, 2001	June 21, 2002	June 21, 2003	June 21, 2004	June 21, 2005	June 21, 2006	June 21, 2007	June 21, 2008	June 21, 2009
Maximum Temperature	78.1	77	73	82.9	73.9	87.1	81	88	86	84
Minimum Temperature	57	55	57	48.9	54	64	55.9	55	59	63

Credit: Old Farmer's Almanac, data processed by Jacob Berg

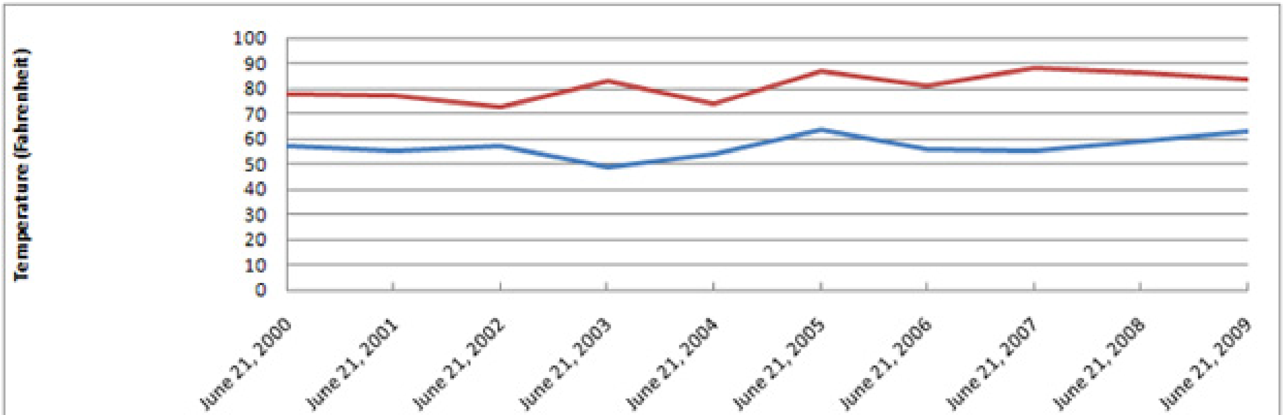
QUANTITATIVE CLIMATE ANALYSIS

Maximum & Minimum Temperatures

June 21, 1990 to June 21, 2009



	June 21, 1990	June 21, 1991	June 21, 1992	June 21, 1993	June 21, 1994	June 21, 1995	June 21, 1996	June 21, 1997	June 21, 1998	June 21, 1999
Maximum Temperature	79	86	64.9	82	84.9	91	82.9	81	77	80.1
Minimum Temperature	57	66	37	55.9	61.9	64.9	61	66	62.1	57



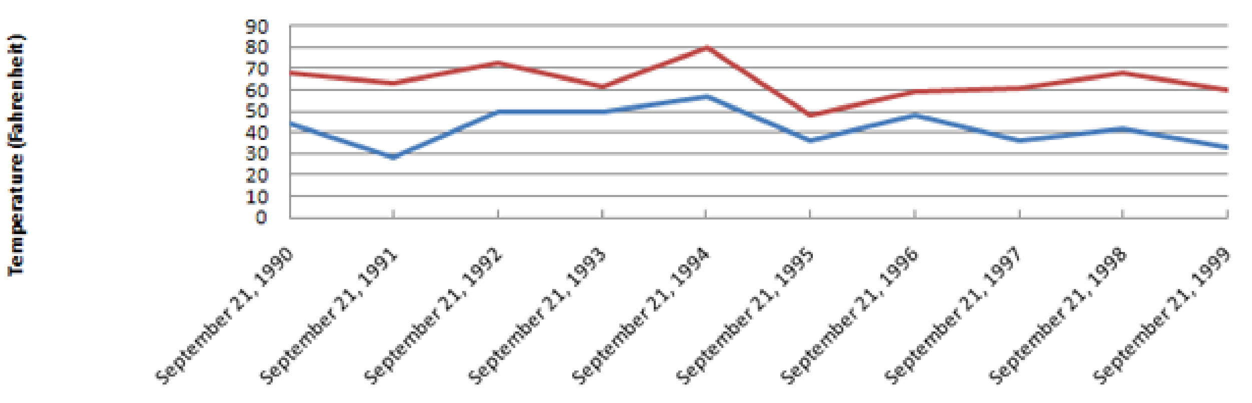
	June 21, 2000	June 21, 2001	June 21, 2002	June 21, 2003	June 21, 2004	June 21, 2005	June 21, 2006	June 21, 2007	June 21, 2008	June 21, 2009
Maximum Temperature	78.1	77	73	82.9	73.9	87.1	81	88	86	84
Minimum Temperature	57	55	57	48.9	54	64	55.9	55	59	63

Credit: Old Farmer's Almanac, data processed by Jacob Berg

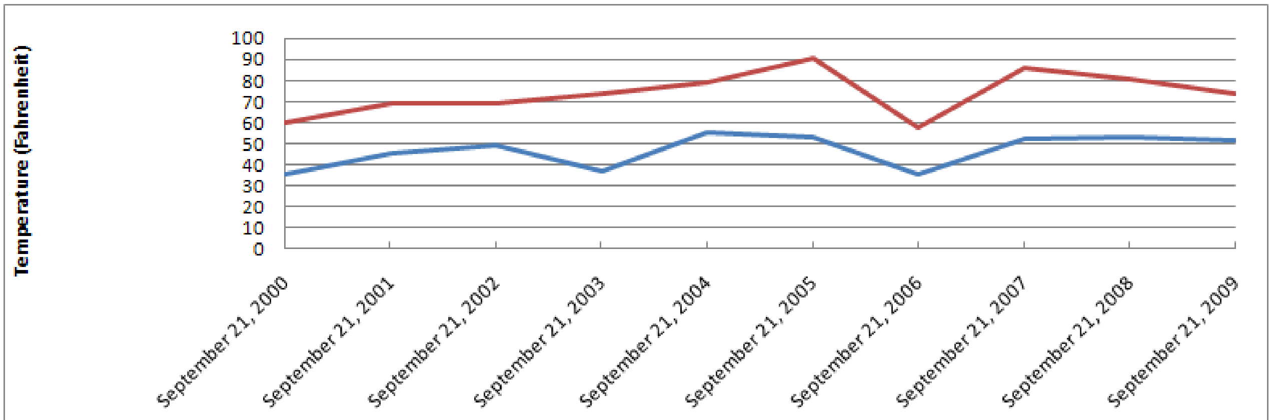
QUANTITATIVE CLIMATE ANALYSIS

Maximum & Minimum Temperatures

September 21, 1990 to September 21, 2009



	September 21, 1990	September 21, 1991	September 21, 1992	September 21, 1993	September 21, 1994	September 21, 1995	September 21, 1996	September 21, 1997	September 21, 1998	September 21, 1999
Maximum Temperature	68	63	73	61.9	80.1	48	59	61	68	60.1
Minimum Temperature	44.1	28	50	50	56.8	36	48	36	42.1	33.1



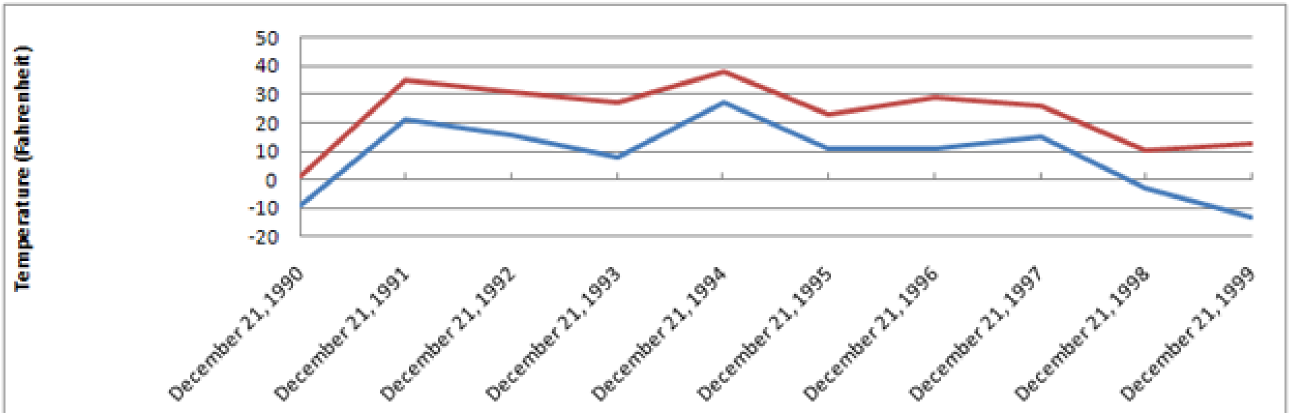
	September 21, 2000	September 21, 2001	September 21, 2002	September 21, 2003	September 21, 2004	September 21, 2005	September 21, 2006	September 21, 2007	September 21, 2008	September 21, 2009
Maximum Temperature	60.1	69.1	69.1	73.9	79	91	57.9	86	81	73.4
Minimum Temperature	35.1	45	48.9	37	55	53.1	35.1	52	53.1	51.8

Credit: Old Farmer's Almanac, data processed by Jacob Berg

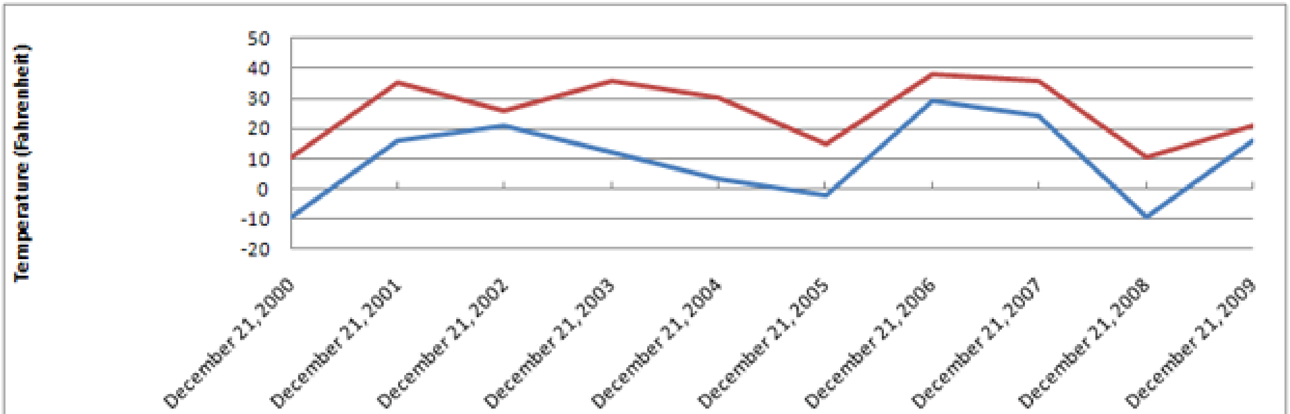
QUANTITATIVE CLIMATE ANALYSIS

Maximum & Minimum Temperatures

December 21, 1990 to December 21, 2009



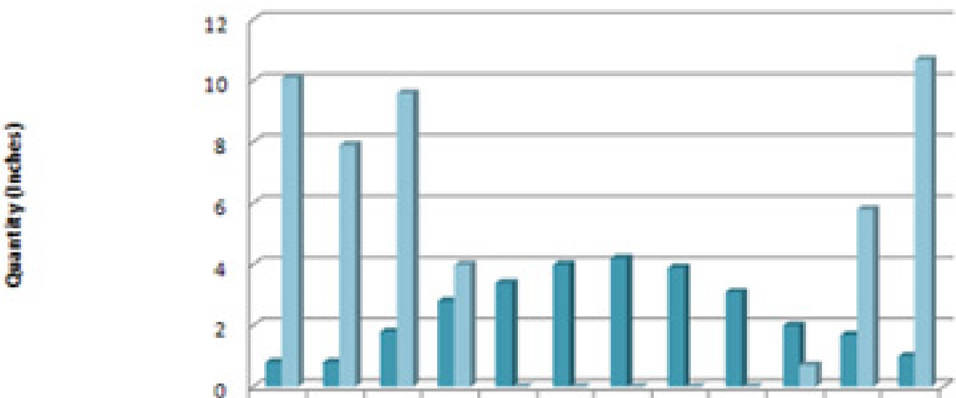
	December 21, 1990	December 21, 1991	December 21, 1992	December 21, 1993	December 21, 1994	December 21, 1995	December 21, 1996	December 21, 1997	December 21, 1998	December 21, 1999
Maximum Temperature	1	35.1	30.9	27	37.9	23	28.9	26.1	10.4	12.9
Minimum Temperature	-9.2	21	16	7.9	27	10.9	10.9	15.1	-2.9	-13



	December 21, 2000	December 21, 2001	December 21, 2002	December 21, 2003	December 21, 2004	December 21, 2005	December 21, 2006	December 21, 2007	December 21, 2008	December 21, 2009
Maximum Temperature	10.4	35.1	26.1	36	30.2	15.1	37.9	36	10.4	21.2
Minimum Temperature	-9.4	15.8	21.2	12	3.2	-2	29.1	24.1	-9.4	15.8

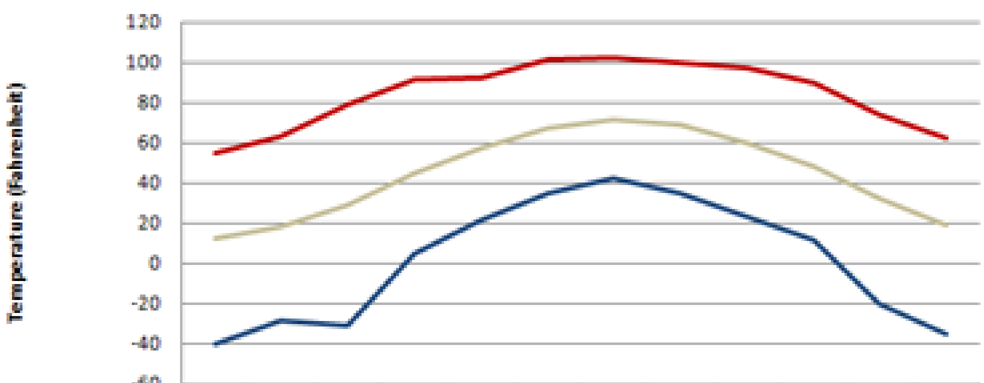
Credit: Old Farmer's Almanac, data processed by Jacob Berg

1980-2009 Average Precipitation & Snowfall



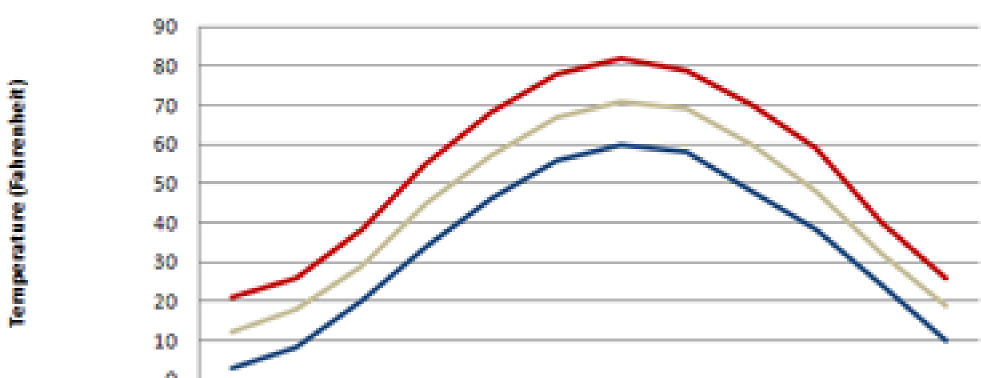
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Average Precipitation	0.8	0.8	1.8	2.8	3.4	4	4.2	3.9	3.1	2	1.7	1
Average Snowfall	10.1	7.9	9.6	4	0	0	0	0	0	0.7	5.8	10.7

1970-2009 Record Low & High Temperatures



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Record High	55	63	79	91	92	101	102	100	97	90	74	62
Average	12	18	29	45	57	67	71	69	60	48	32	19
Record Low	-40	-29	-31	5	21	35	42	35	23	11	-20	-35

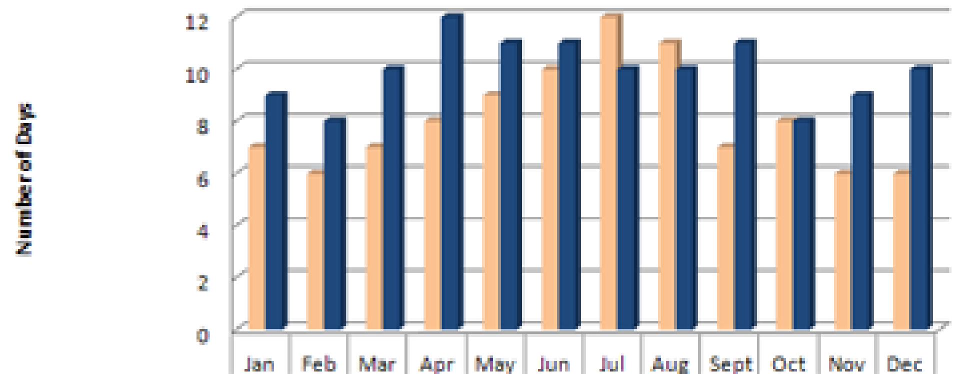
1970-2009 Average Low & High Temperatures



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Average High	21	26	38	55	68	78	82	79	70	59	40	26
Average	12	18	29	45	57	67	71	69	60	48	32	19
Average Low	3	8	20	34	46	56	60	58	48	38	24	10

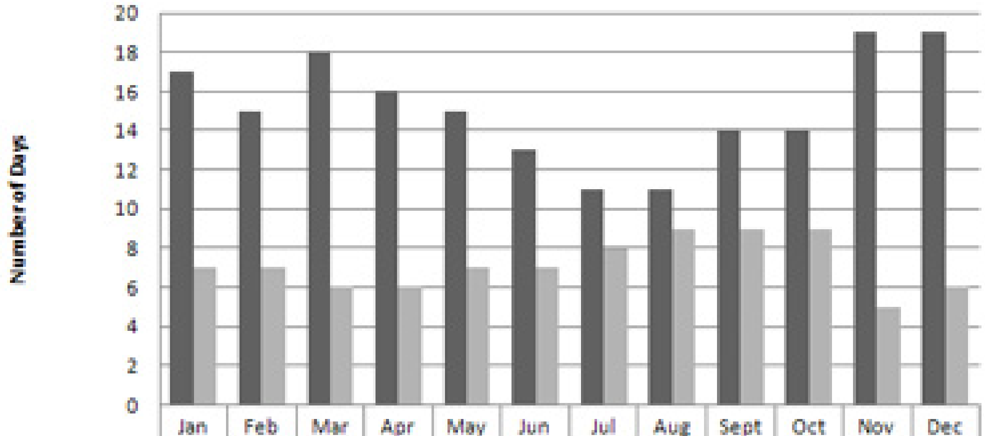
Credit: Old Farmer's Almanac, data processed by Jacob Berg

1980-2009 Average Partly Cloudy & Rainy Days



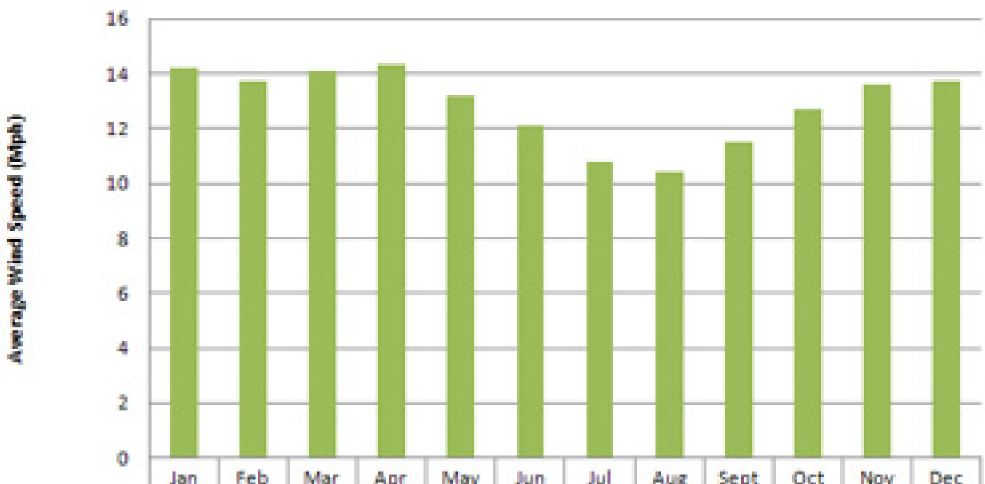
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Partly Cloudy Days	7	6	7	8	9	10	12	11	7	8	6	6
Rainy Days	9	8	10	12	11	11	10	10	11	8	9	10

1980-2009 Average Cloudy & Clear Days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Cloudy Days	17	15	18	16	15	13	11	11	14	14	19	19
Clear Days	7	7	6	6	7	7	8	9	9	9	5	6

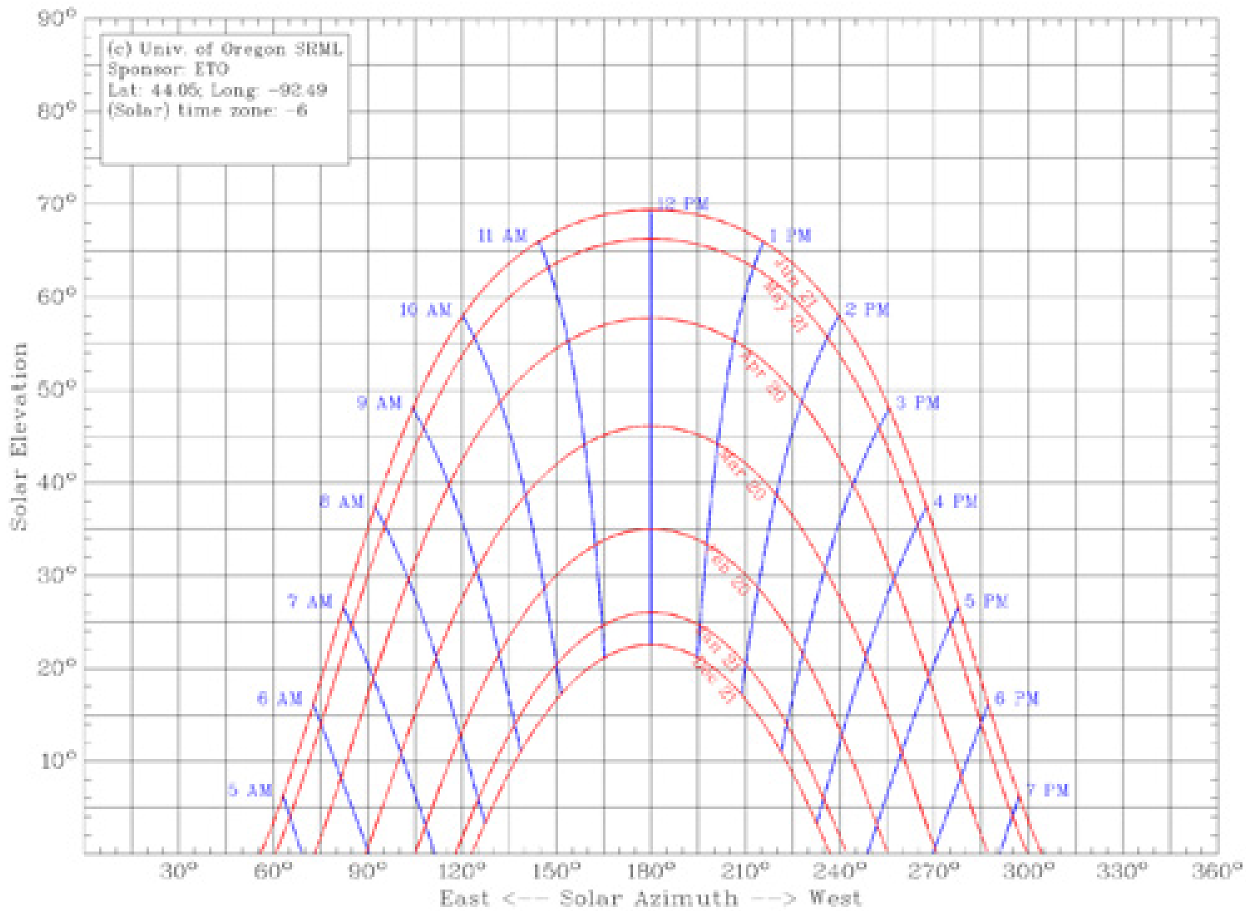
1980-2002 Average Wind Speed



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Wind Speed	14.2	13.7	14.1	14.3	13.2	12.1	10.8	10.4	11.5	12.7	13.6	13.7

Credit: Old Farmer's Almanac, data processed by Jacob Berg

SOLAR ELEVATION CHART:



ENVIRONMENTAL CONSEQUENCES:

Environmental variability is one reason why urban parks lack a long life expectancy. Temperatuce, solar radiation, and precipitation are changing continually with yearly seasons and in the long term with adaptive cycles. A plant's adaptability can vary with an unusual deep winter freeze or excessive summer heat. Landscapes, as with humans, will not live forever and experience ecological successions to counteract a wide range of plant populations. Our design actions accelerate direct environmental changes such as major floods. Long-term planning, as noted with Jens Jensen's Columbus Park, can defy the professional status quo and be extended for decades. It is up to landscape architects to catalyze change and as former landscape architect, Ian McHarg stated, "Design a landscape based on what it wants to be." Urban parks will continue to deteriorate as habitat fragmentations reduce ecological corridors. Biodiversity continues to diminish due to traditional and contemporary design practices that do not fully understand an environment's impact on our landscapes.

PROGRAMMATIC REQUIREMENTS

SILVER LAKE PUBLIC GREEN SPACE

Riparian Buffers (392,050 sq. ft) ________ 9 acres

Wooded Aspen-Oak Forest (91,000 sq. ft) ________ 2.1 acres

Stormwater Management Landscapes (225,000 sq. ft) ________ 5 acres

Wetland Restoration (130,000 sq. ft) ________ 3 acres

TOTAL ACERAGE: 19 acres

PUBLIC GREEN CONNECTIONS

Expanded Green Connections (180,333 sq. ft) ________ 2.5 acres

Road Modifications (90,000 sq. ft) ________ 2 acres
- West Silver Lake Dr.
- East Silver Lake Dr.
- 7th St. N

TOTAL ACERAGE: 4.5 acres

PROGRAMMATIC REQUIREMENTS

PUBLIC GREEN SPACE

Riparian Buffers (392,050 sq. ft)	9 acres
Wooded Aspen-Oak Forest (91,000 sq. ft)	2.1 acres
Stormwater Management Landscapes (225,000 sq. ft)	5 acres
Wetland Restoration (130,000 sq. ft)	3 acres
TOTAL ACERAGE:	19 acres

TABLE OF CONTENTS

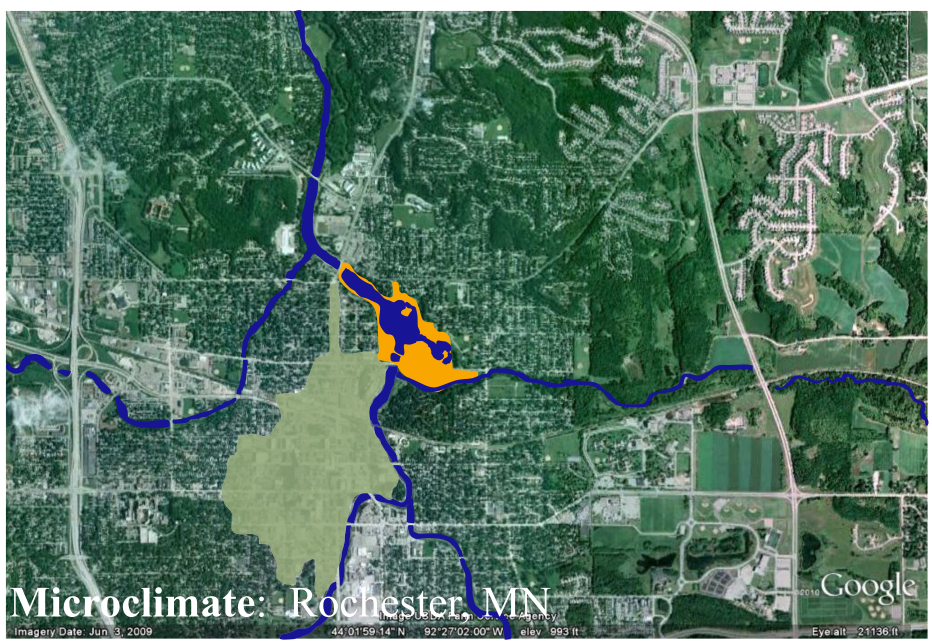
Ecological Resilient Landscapes: Averting a Pending Disaster

Regional Context: Rochester, MN

Silver Lake Park is located in Rochester, MN, which is approximately 90 miles southeast of St. Paul and Minneapolis.

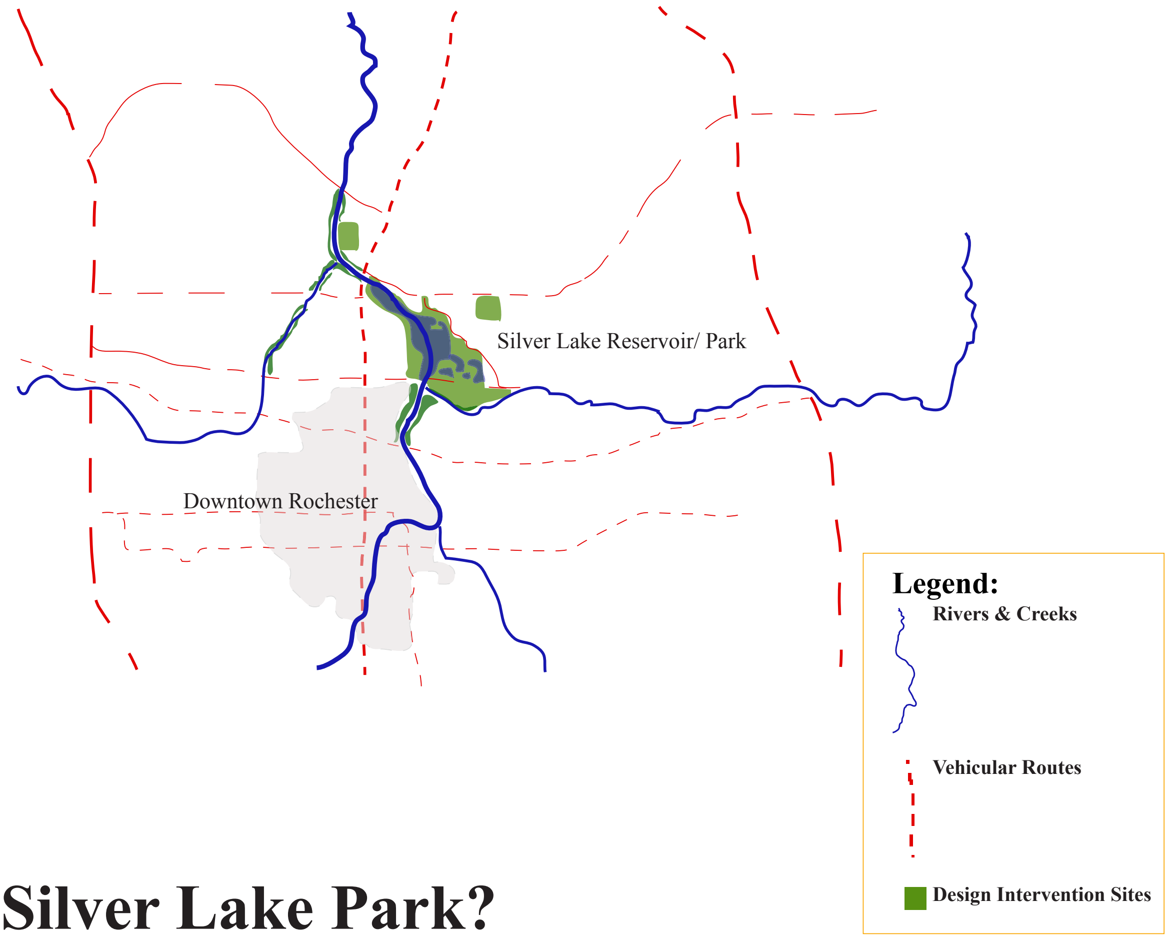
Downtown Rochester is less than a mile southwest of Silver Lake Park.

Community Context: Silver Lake Park



East Pioneers, Glendale and Northrop neighborhoods with low density residential housing surround this public green space from all sides. Commercial businesses are primarily west of Silver Lake along North Broadway.

Regional Context: Rochester, MN



Why Silver Lake Park?

- An aging urban park at a new transition.
I.e. Site uses are not adapting to site user demographics.

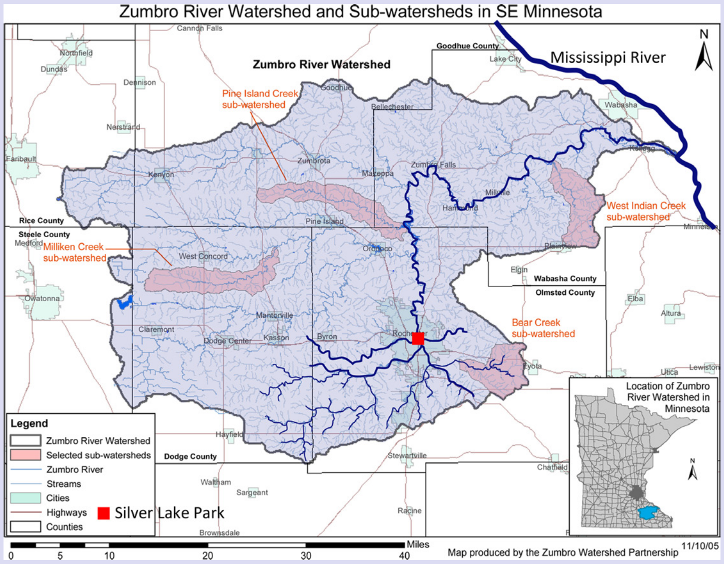
- Habitat fragmentation from existing infrastructure.
I.e. North Broadway, 14th St. NE. & 7th St. NE.

- Urban development expanding northeast.
I.e. Downtown Rochester; U of MN campus & Mayo Clinic.

- Existing flood mitigation lacks long-term planning.
I.e. Moves stormwater as soon as possible to develop other potential problems.

- Disappearing wildlife corridors.
I.e. Zumbro Riverside development.

DESIGN OBJECTIVES

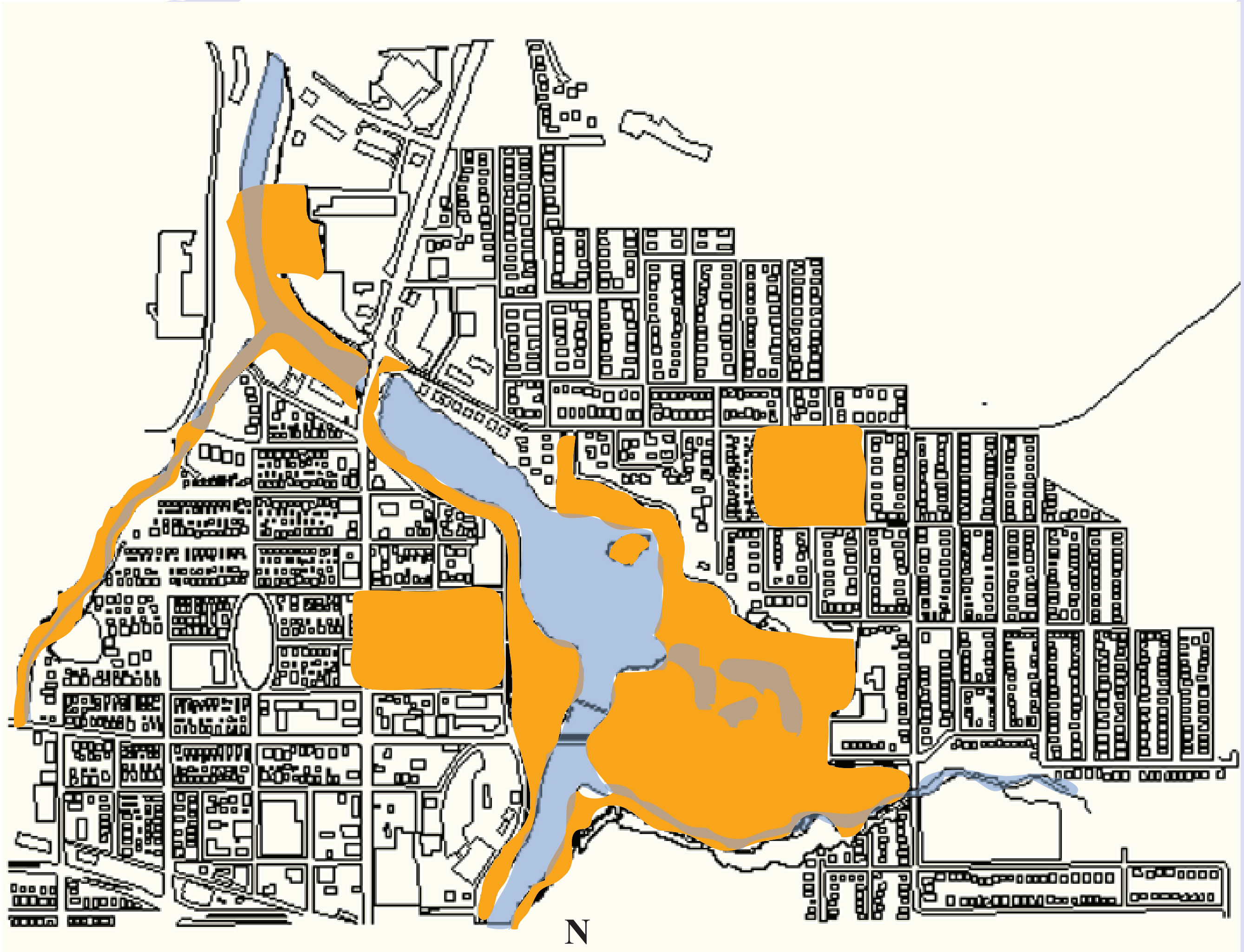


Silver Lake Park will provide. . .

- An **ecological park** attracting both site users and wildlife.
- Connections to **regional greenscapes** with a renewed focus on pedestrian accessibility.
- Attract students, young families and older adults with **affordable and biophilic oriented lifestyles.**
- Control stormwater runoff at adjacent creeks and **design for a regional hydrological cycle.**
- **Establish wildlife corridors** along riparian landscapes.

DESIGN OBJECTIVES

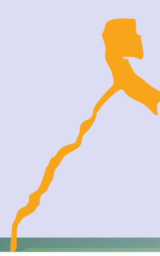
Proposed Design Interventions:



Silver Lake Park
& Reservoir

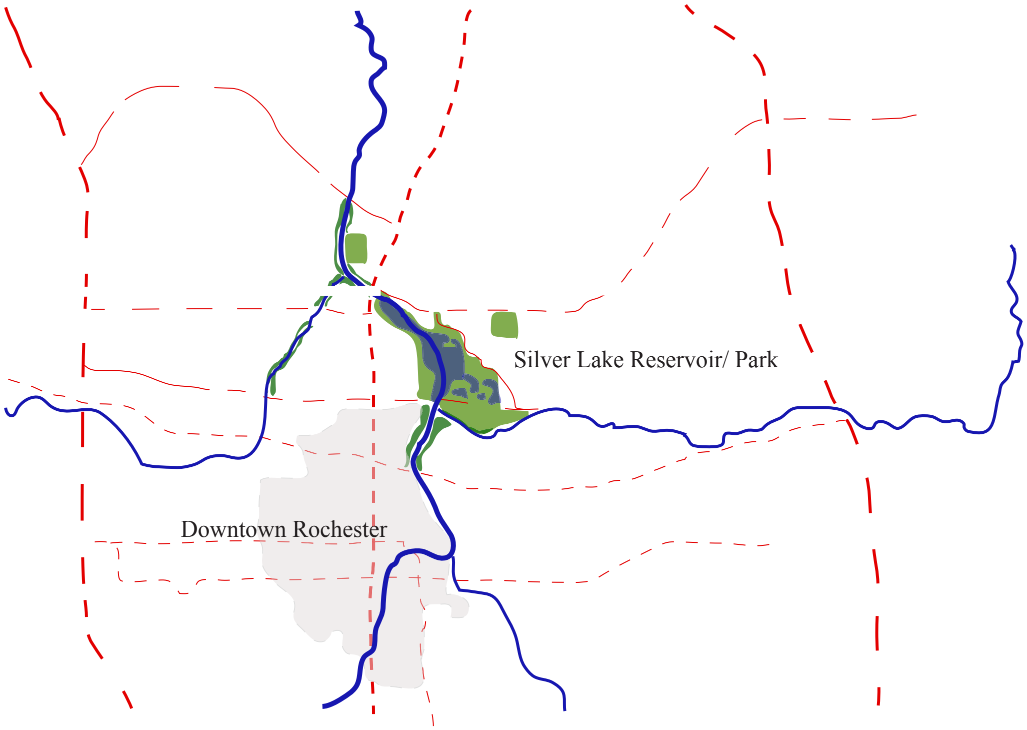
9th St. NE. Apartments

Northbrook Apartments



Jefferson Elementary
(Green Schools)

Biophilic Cities: Integrating Nature into Urban Design



BIOPHILIC CITIES: Integrating Nature into Urban Design & Planning

- Nature focused, which includes green features, life-forms and processes.
- Easily accessible to abundant nature.
- Rich textured, multi-sensory landscapes.

-Credit: Timothy Beatley. Biophilic Cities: Integrating Nature into Urban Design & Planning, p. 46 & 52.

DESIGN OBJECTIVES

Biophilic Cities: Integrating Nature into Urban Design

1. REGION:
Regional Green spaces

Riparian Systems & Restoration

2. COMMUNITY:
Urban ecological corridors
Community forests

Green Schools

3. NEIGHBORHOOD:
Ecology parks
Community gardens
Neighborhood parks

Urban Forests

4. STREET:
Green streets
Edible Landscaping
Vegetated swales

Urban trees

5. BLOCK:
Adaptable/ naturalized plantings
Concentrated Medium Density

Housing around green spaces

6. BUILDING:
Rooftop or sky gardens
Daylit interior spaces
Vertical gardens

Biophilic Cities: Integrating Nature into Urban Design

1. Reconciling Human Needs & Biodiversity

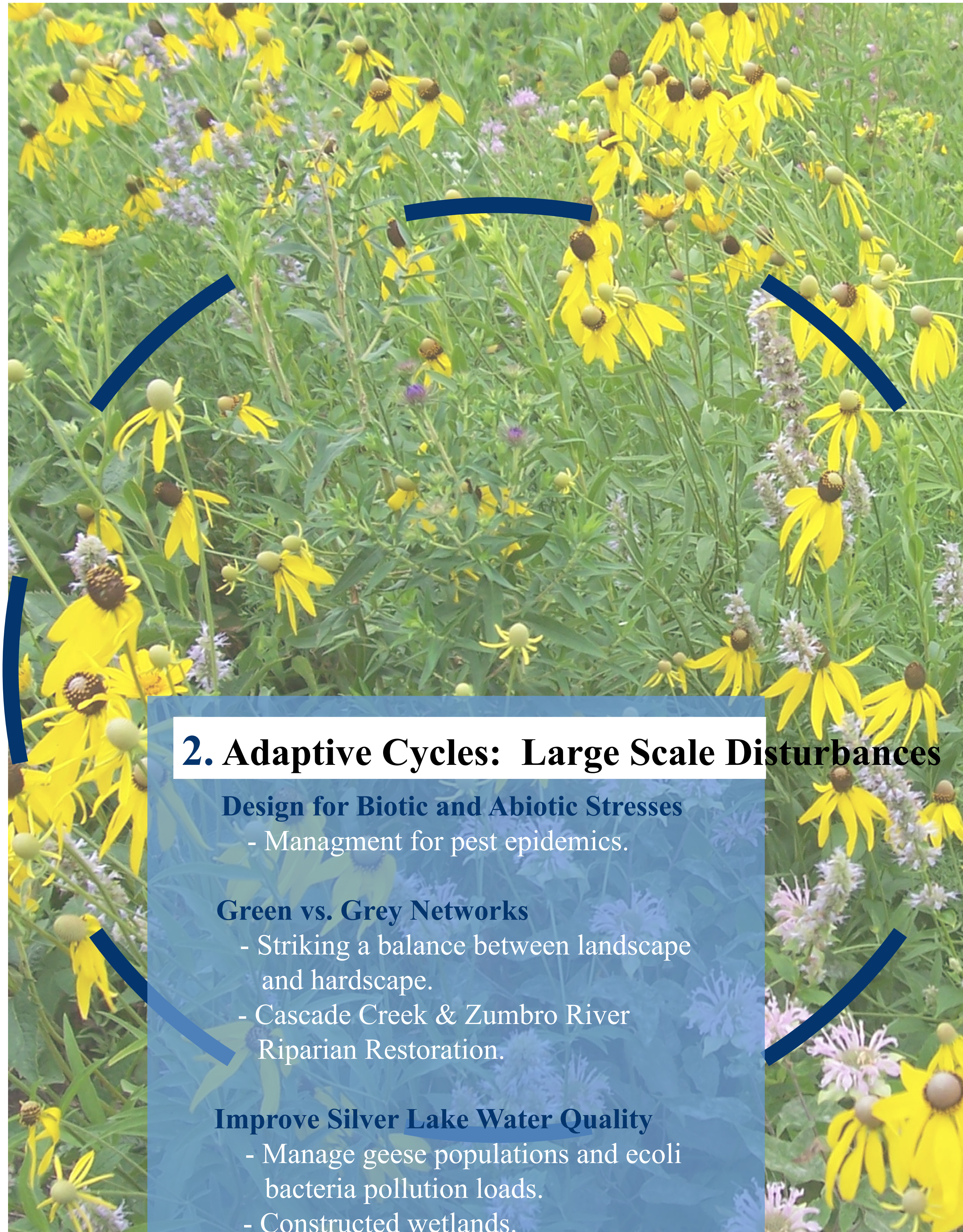
Display ecological processes through design
- Constructed wetlands, naturalized plantings.

Design an urban landscape based on *"what it wants to be" -Ian McHarg*
- Interconnect environmental site analysis with design development.

Biodiversity
- Plant site-specific plant compositions.

DESIGN OBJECTIVES

Biophilic Cities: Integrating Nature into Urban Design



2. Adaptive Cycles: Large Scale Disturbances

Design for Biotic and Abiotic Stresses
- Managment for pest epidemics.

Green vs. Grey Networks
- Striking a balance between landscape and hardscape.
- Cascade Creek & Zumbro River Riparian Restoration.

Improve Silver Lake Water Quality
- Manage geese populations and ecoli bacteria pollution loads.
- Constructed wetlands.

Biophilic Cities: Integrating Nature into Urban Design

3. Long-Term Landscape Planning

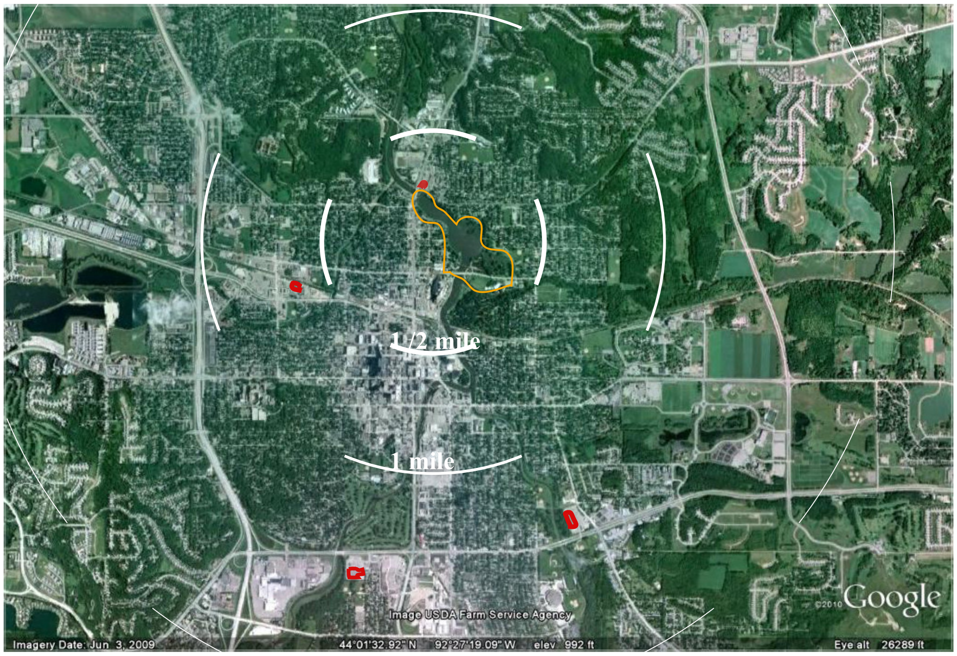
"Think Big, Think Connected, ThinkWhole"
(Ryn and Cowen, 1996)
- Ecological Corridors.

Prevent future habitat fragmentation
- Design beyond a site's boundaries.
- Reconnect fragmented landscapes.

Diversify Land Use Planning
- Utilize urban land to expand public green connections.

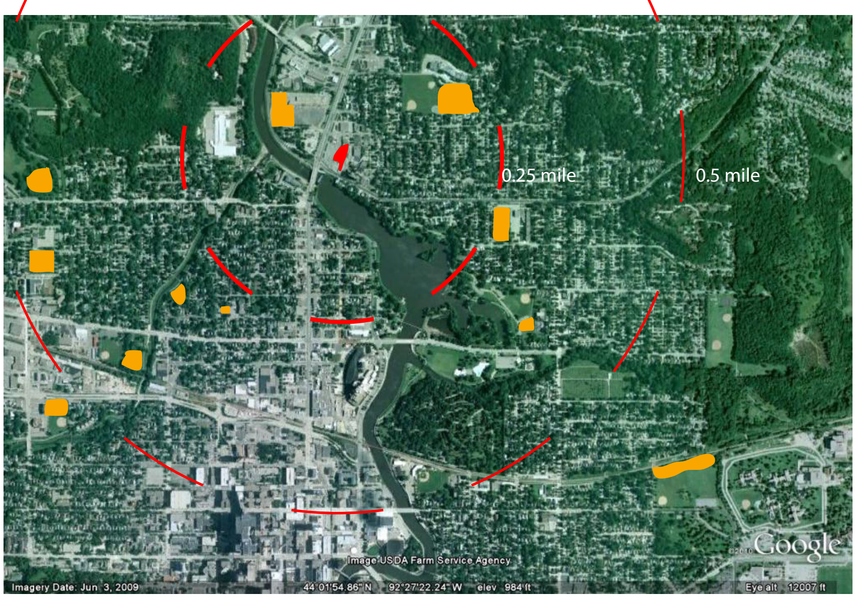
REGION:

Existing Grocery Stores:



2 miles

Large chain grocery stores are available within 0.5 to 1.5 miles away. Silver Lake Foods is the only local grocer with a small quantity of supplies.

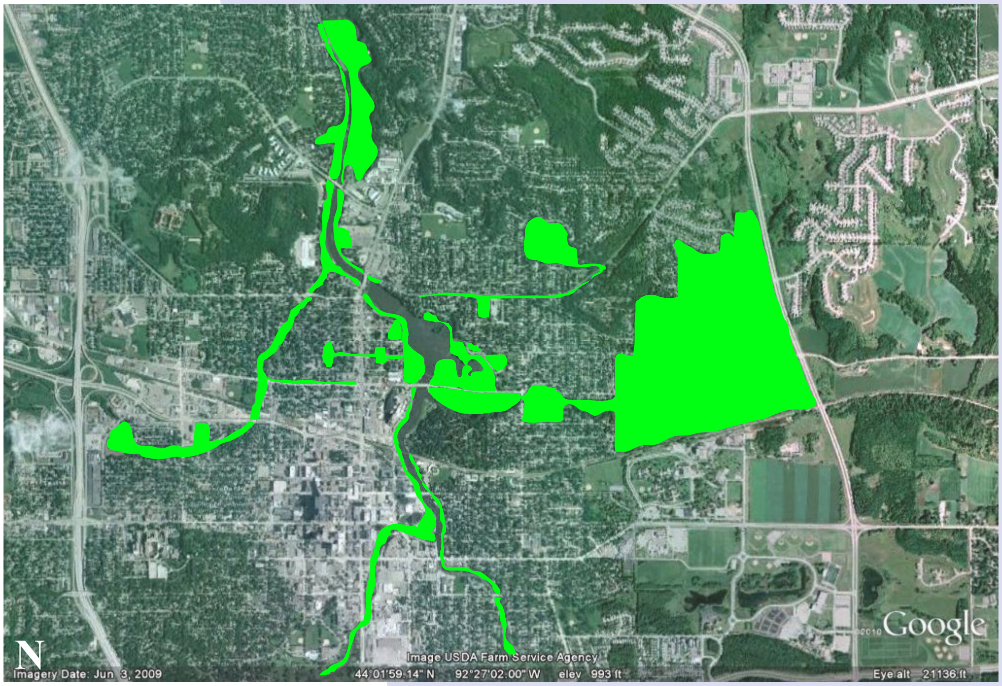


Potential Community Garden Sites:

The dowtown district lacks any available community gardens for medium density housing. **Schools** and **vacant lots** can serve as potential community gardens.

REGION:

Phase 1: Proposed Ecological Corridors



PHASE 1: Proposed Ecological Corridors

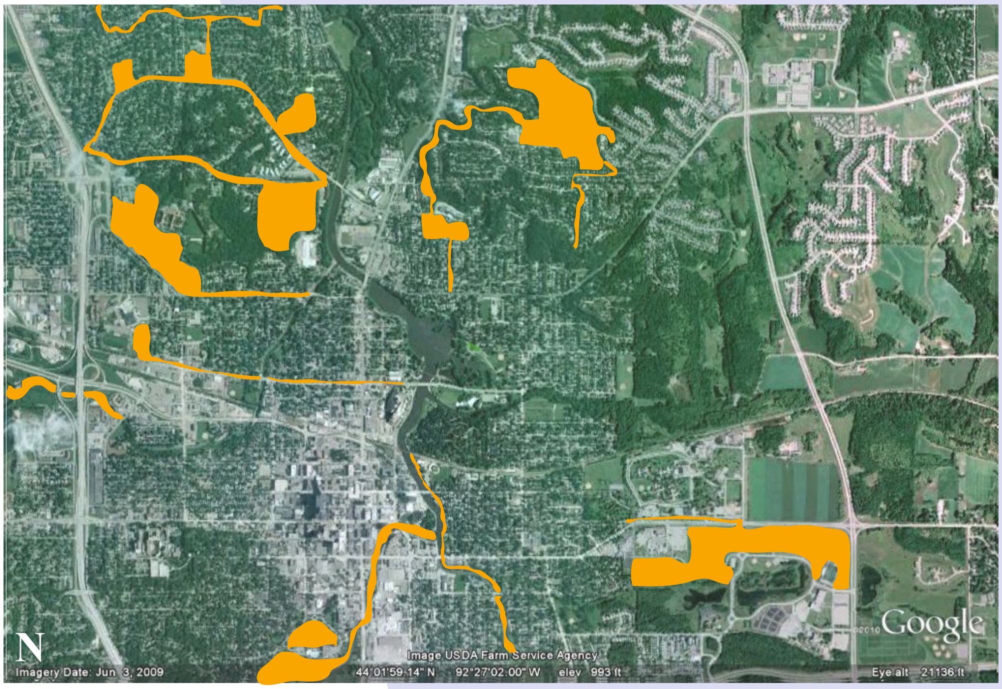
- Connect fragmented public green spaces.

- Establish Zumbro River as a main riparian corridor for humans and wildlife.

- Renew focus on narrow streets to have pedestrians dominating over vehicular traffic.

REGION:

Phase 2: Proposed Green Spaces



PHASE 2: Proposed Green Spaces

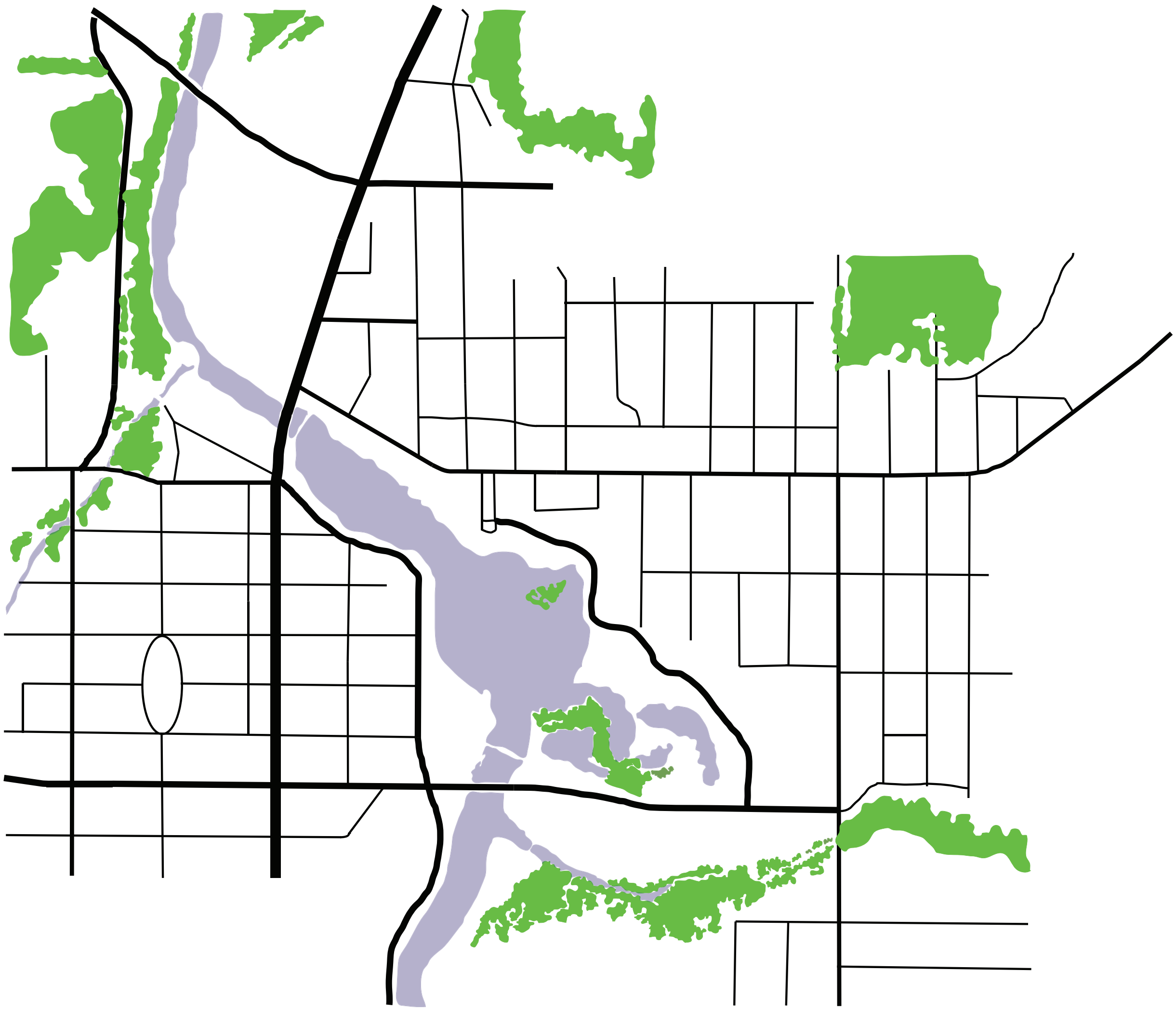
- Expand pedestrian connections further into the heart of downtown Rochester.

- Connect public schools, which are landscapes all local residents pay taxes on.

- Develop green wedges beyond 2 miles for Silver Lake Park into a regional trail system.

REGION:

Riparian Restoration: Existing Riparian Buffers



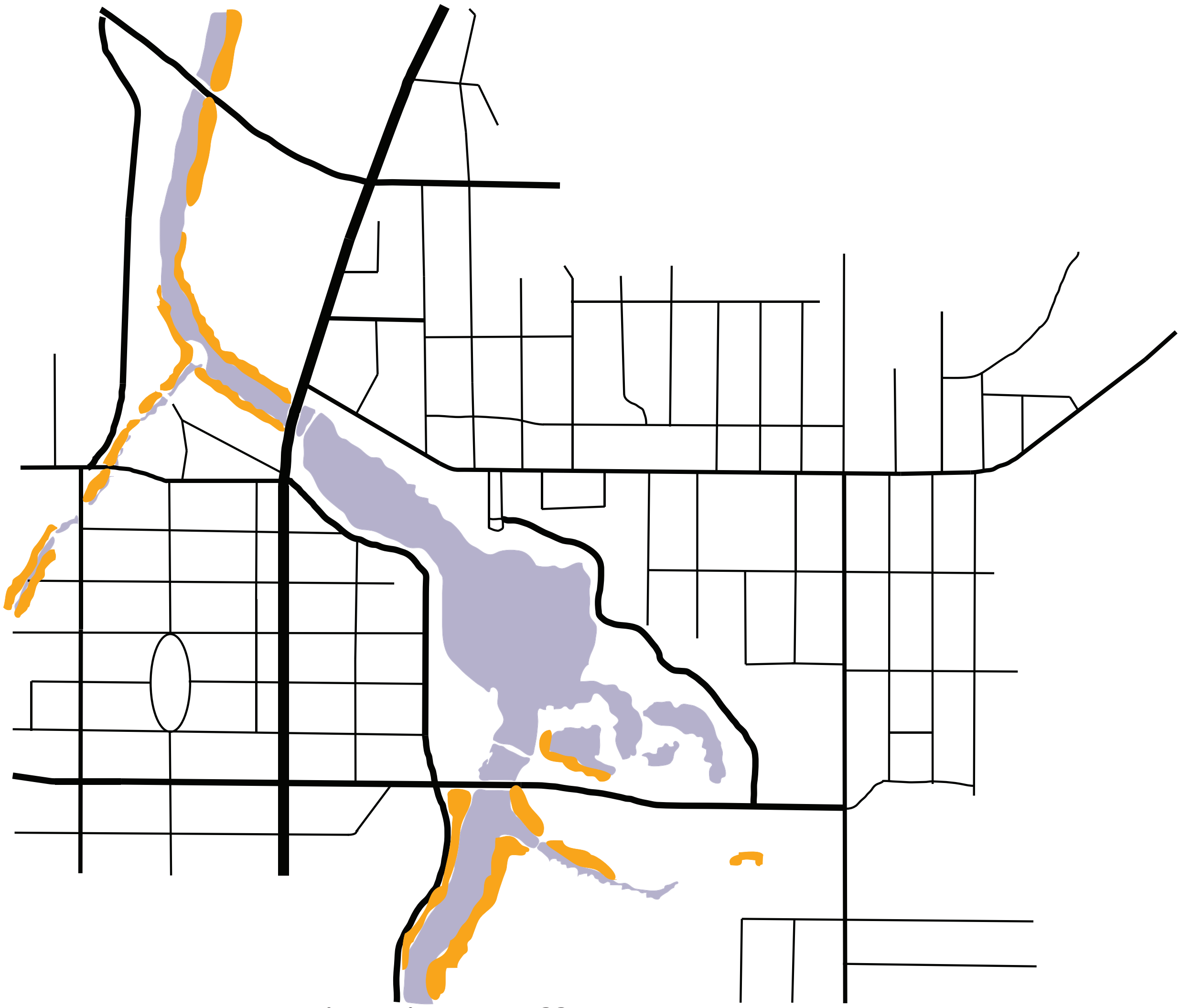
Existing Riparian Buffers:

Riparian buffers using indigenous MN trees and shrubs have potential to help alleviate stormwater runoff into the Zumbro River.

Silver Lake Dam- 1978 Flood

REGION:

Riparian Restoration: Proposed Riparian Buffers



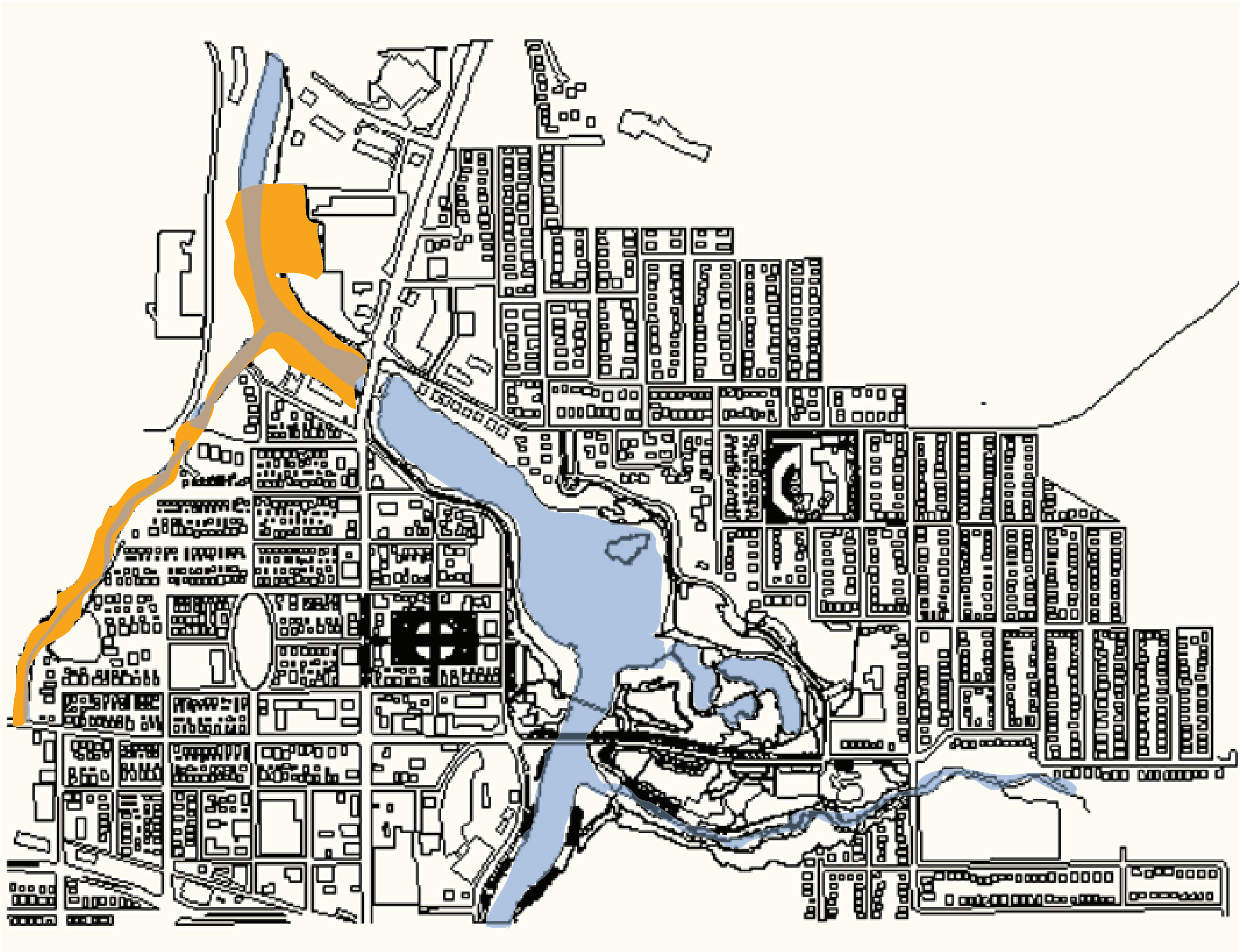
Proposed Riparian Buffers:

Trees such as quaking aspen dominated the regional landscape prior to presettlement which balanced flooding.

Urban development has drastically altered regional hydrologic patterns through the vast removal of riparian buffers. Flood tolerant trees and shrubs are placed to the west of Silver Lake dam, Cascade Creek and between the downtown/ Silver Lake corridor.

REGION:

Proposed Northbrook Apartments:

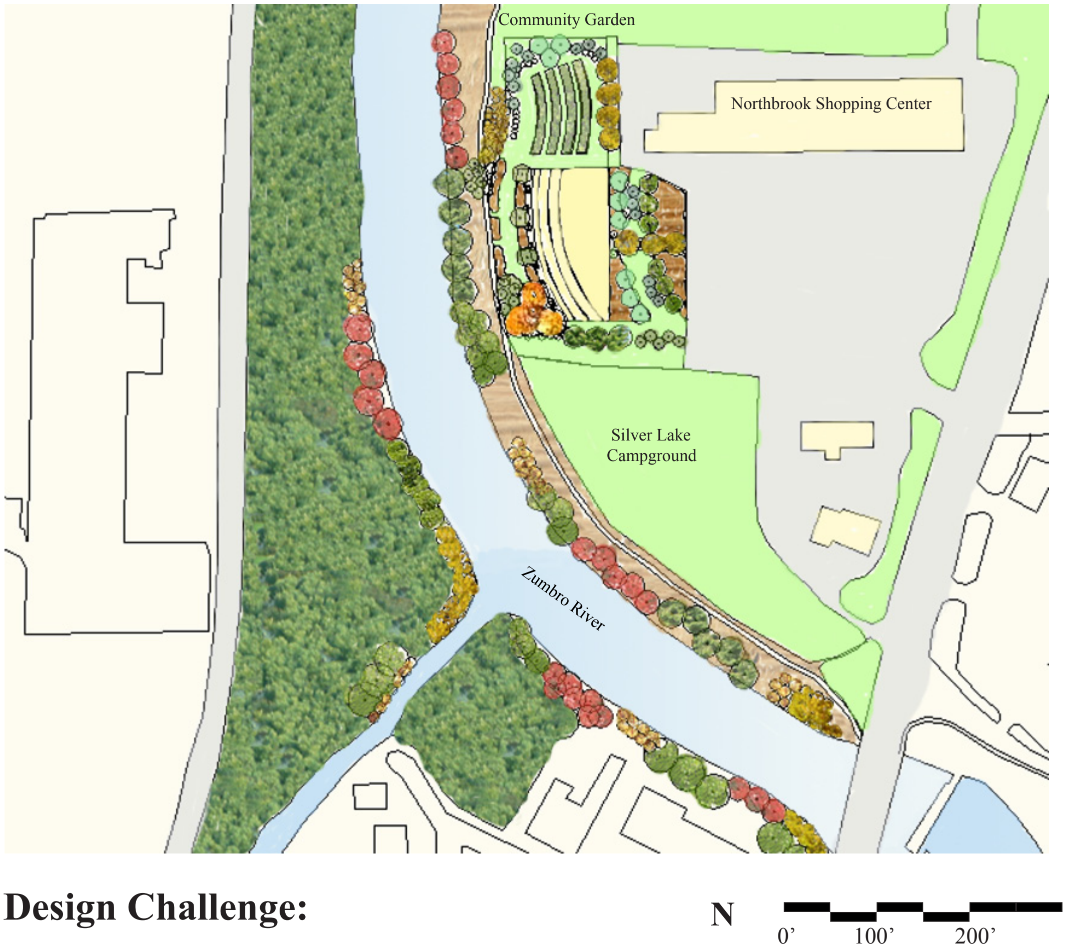


Northbrook Apartments are situated on the former riverside property of Cinema 3 Theatre. Cinema 3 Theatre closed in 2002 due to more advanced movie theaters in Rochester. The site has been vacant for numerous years until it was demolished. in 2009. It is currently used to store snow off of the Northbrook Shopping Center parking lot.

Problem: Vacant Riverside Property

REGION:

Northbrook Apartments: Master Plan & Ecological Corridors



Design Challenge:

Closest farmer’s market is downtown Rochester (>1 mile).

A smaller secondary market can be established near the Northbrook apartments and shopping center. Food can be sold to local restaurants.

Design Solutions:

1. Provide affordable medium density housing.
2. Engage surrounding neighborhoods.
3. Establish naturalized plantings.
4. Zumbro River riparian restoration.
5. Situate apartment building with a community garden.

REGION:

Riparian Restoration: Zumbro River Tree Plantings

Our design implications affect **site, community and regional** hydrology cycles.

Q**uarry Hill Nature Center** can **coordinate riparian buffer plantings** with local schools and the Rochester Parks Department.

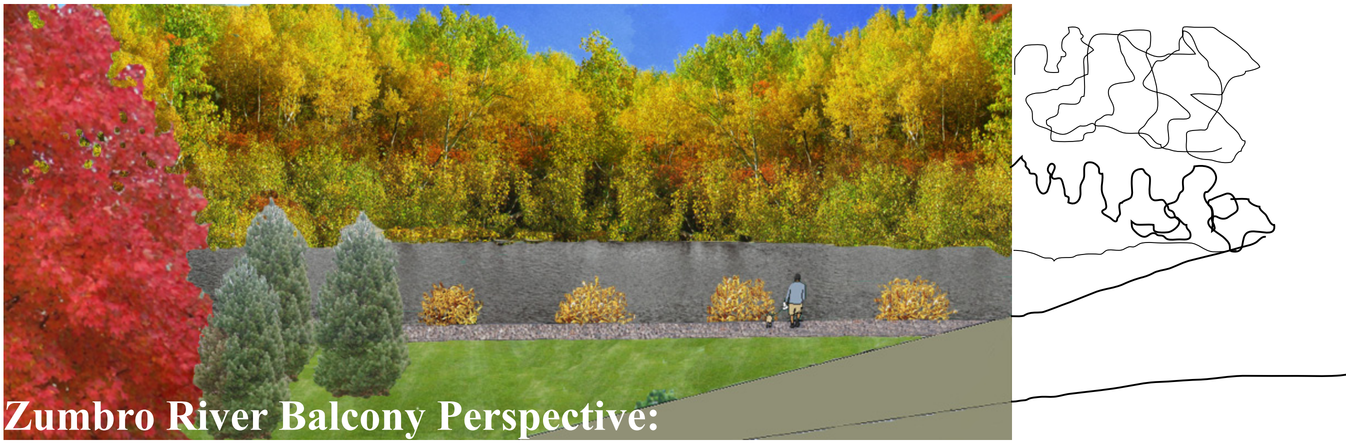
Z**umbro Valley Audubon Society** serves Rochester, MN and provides birdwatching experiences. Riparian buffers can increase songbird and migratory bird populations.

M**icroorganisms, wildlife, plants and fungi** all benefit when natural processes are not significantly manipulated through design.

Quarry Hill Nature Center:

REGION:

Northbrook Apartments: Riverside Perspectives



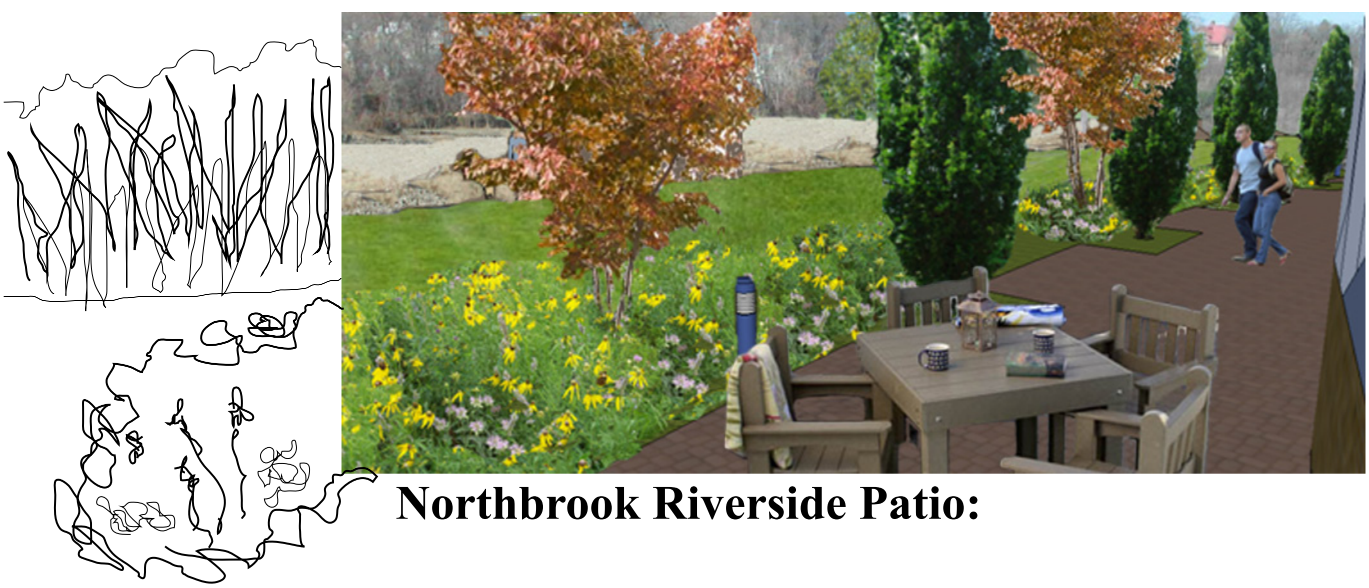
Zumbro River Balcony Perspective:

Northbrook Apartments provide **benefits** for residents:

1. Access to **regional bike and walking trails.**

2. **Zumbro Riverfront.**

3. **Diverse landscape** environment.



Northbrook Riverside Patio:

REGION:

Riparian Restoration: Zumbro River Deciduous Trees

Riparian Buffers:

1. **Provide habitat** for wildlife, fungi and microorganisms.

I.e. Fallen Debris

2. **Flood Hazard Mitigation** for future floods through the use of adaptable MN trees and shrubs.

I.e. Hydraulic control through trees.

REGION:

Riparian Restoration: Proposed MN Native Deciduous Trees

Acer rubrum

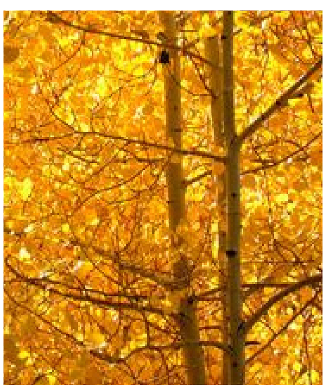
Betula nigra

Carpinus caroliniana

Malus x 'Dolgo'

Ostrya virginiana

Populus balsamifera



Populus tremuloides

Prunus serotina

Quercus bicolor

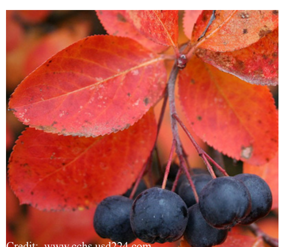
Quercus ellipsoidalis

REGION:

Riparian Restoration: Cascade Creek MN Native Shrubs

Cascade Creek Recreational Trails: Early Fall

Amelanchier laevis



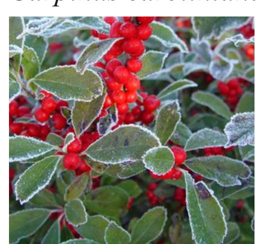
Aronia melanocarpa

Carpinus caroliniana

Comptonia peregrenia

Corylus cornuta

Dirca palustris



Ilex verticella

Salix alba 'Flame'

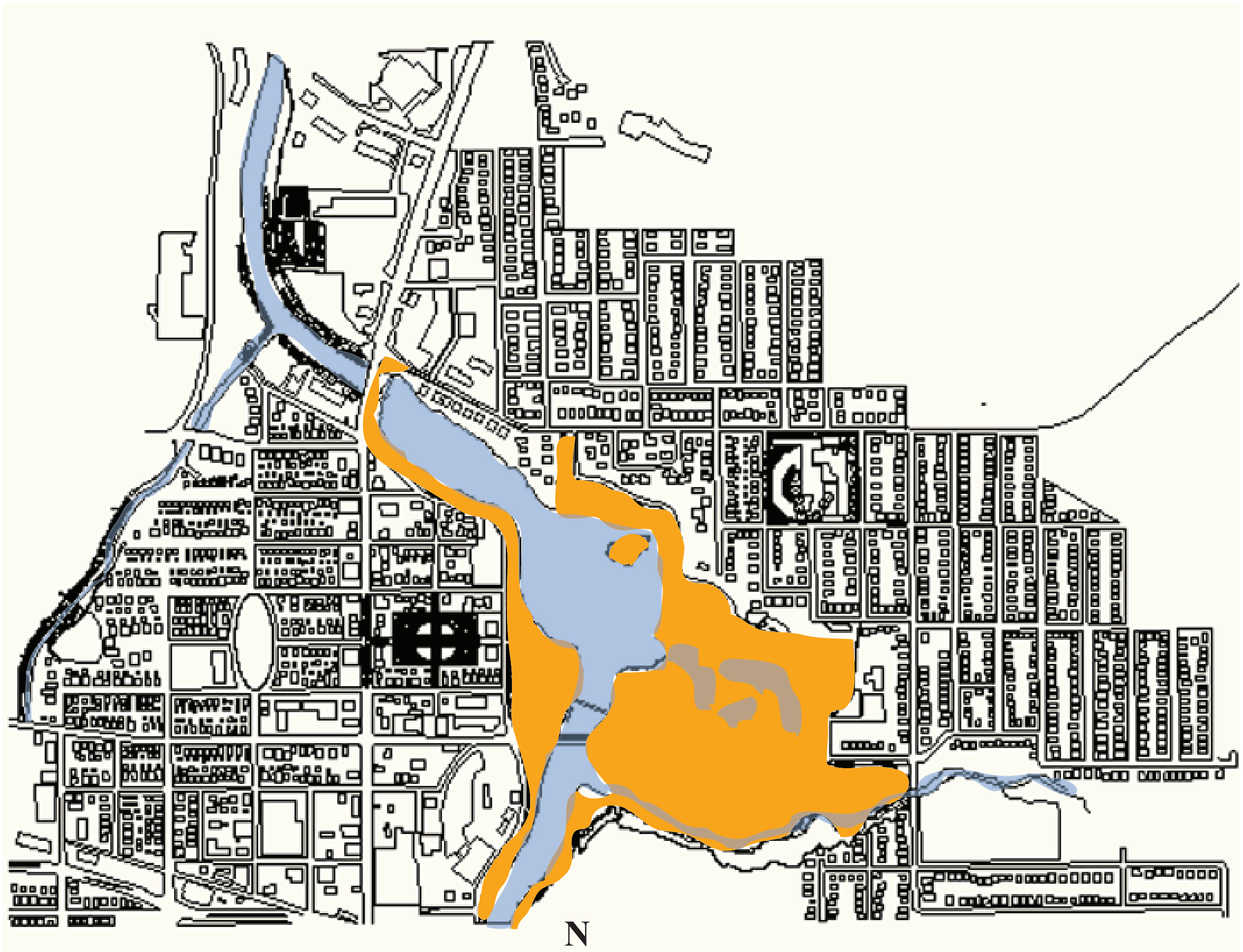
Salix interior

Sambucus canadensis

Viburnum rafinesquianum

REGION:

Silver Lake Park & Reservoir:

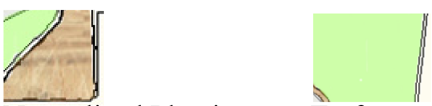


Silver Lake Park serves as an ideal environment for thousands of giant Canadian geese. The Rochester Public Utilities Power Plant discharges warm water into Silver Lake Reservoir during the winter, which prevents the lake from freezing over.

REGION:

Silver Lake Reservoir: Naturalized Plantings

Silver Lake Reservoir Master Plan:



Naturalized Plantings   Turfgrass

N
0’   200’   400’

Design Challenge:

- **Manage giant Canadian geese** population while increasing migratory and songbird species.

Naturalized plantings and a deep marsh provide diverse ecological compositions to discourage a majority of the current 35,000 to 40,000 giant Canadian geese.

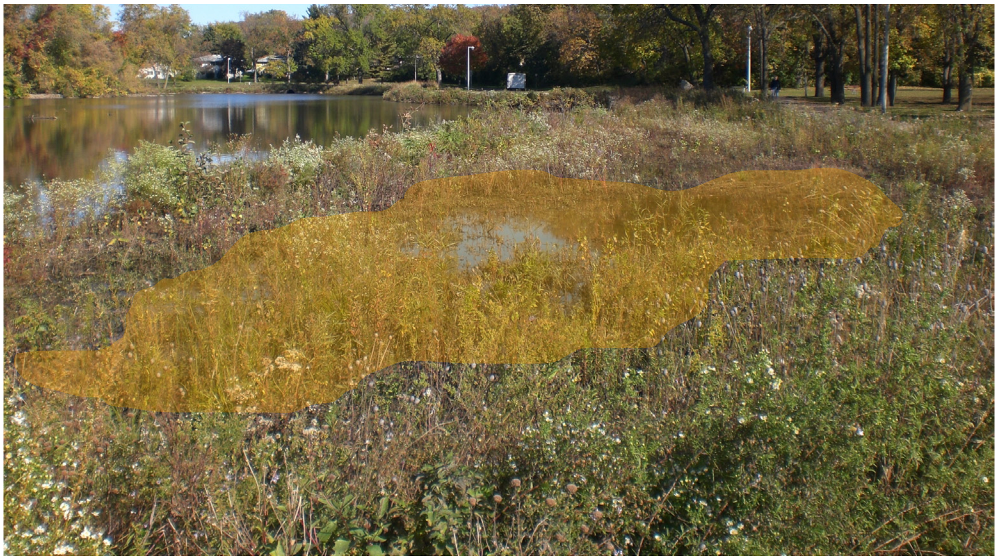
Giant Canadian Geese:

Design Solutions:

1. Create a deep constructed marsh.
2. Provide habitat and food sources for migratory and songbirds.
3. Establish naturalized plantings.
4. Develop direct green connections.
5. Design with regional green spaces.

REGION:

Silver Lake Reservoir: Constructed Deep Marsh



Site-specific plant compositions are essential if diversity is a major design objective for Silver Lake and adjacent neighborhoods. Inadequate plant locations can result in a lack of a thorough site analysis and setting back a landscape's success.

Potential Constructed Deep Marsh:

A constructed deep marsh can help **balance the ecoli bacteria problem** from excessive giant Canadian geese populations.

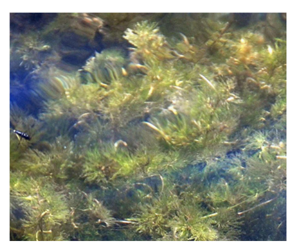
REGION:

Silver Lake Reservoir: Constructed Deep Marsh

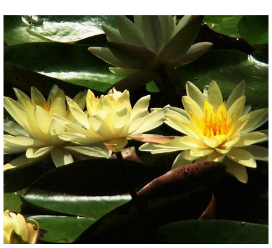
Potential MN Wetland Plant Compositions:

Brasenia schreberi
Watershield

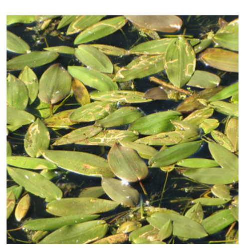
Ceratophyllum demersum
Coonstail



Myriophyllum sp.
Water Milfoil

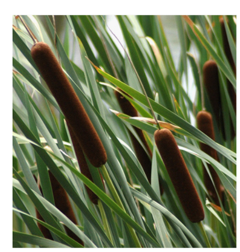


Nuphar lutea
Yellow Waterlily



Potamogeton natans
Floating Pondweed

Scirpus acutus
Hardstem Bulrush



Typha latifolia
Narrow Cattail

Credit: http://www.npwrc.usgs.gov/resource/plants/mnplant/marsh.htm

COMMUNITY:

Northbrook Apartments: Neighborhood Involvement

Northbrook apartments are proposed along the Zumbro Riverfront and in proximity to local restaurants. **Project Orange Thumb**, if selected for Rochester, MN could serve as a **catalyst** for **community gardens** in both older and newer neighborhoods.

Mature deciduous trees can limit the amount of both shrubs and vegetables low density residences can produce.

Credit: Renee Moag

Credit: Renee Moag

Community Outreach: Tree Plantings

RNeighborWoods Program:

East Pioneers, Glendale & Northrup Neighborhoods

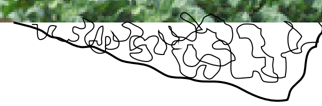
- Coordinate educational seminars through Quarry Hill Nature Center.

- Establish Community Gardens.

- Plant Boulevard/ Urban Forest trees.

Northbrook Apartments: Perennial & Seasonal Food Production

Potential Site Users:



- Northbrook Apartment Residents
- Northrop Neighborhood Residents
- U of MN- Rochester Students

Potential Shrubs & Perennials:

Black & Red Currants

Blueberries
- 'Northblue'
- 'Northcountry'
- 'Northsky'
- 'Polaris'
- 'St. Cloud'

Honeyberries
- 'Berry Belle'
- 'Berry Blue'
- 'Borealis'
- 'Polar Night'
- 'Tundra'

Ligonberry

Nanking Cherry

Strawberries
- 'Ogallala'
- 'Seascape'
- 'Tristar'

Raspberries
- 'Bristol Black'
- 'Double Delight'
- 'Heritage'

Cool Season Vegetables:

Lettuce

Onions (Globe, Sweet Spanish Yellow)

Potatoes

Spinach

Warm Season Vegetables:

Beans

Corn

Cucumbers

Melons

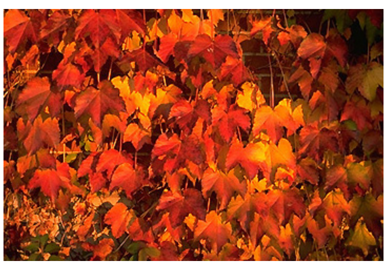
Peppers

Tomatoes

Squash

COMMUNITY:

Northbrook Apartments: Vertical Gardens & Composting Sites:



Vertical Gardens:

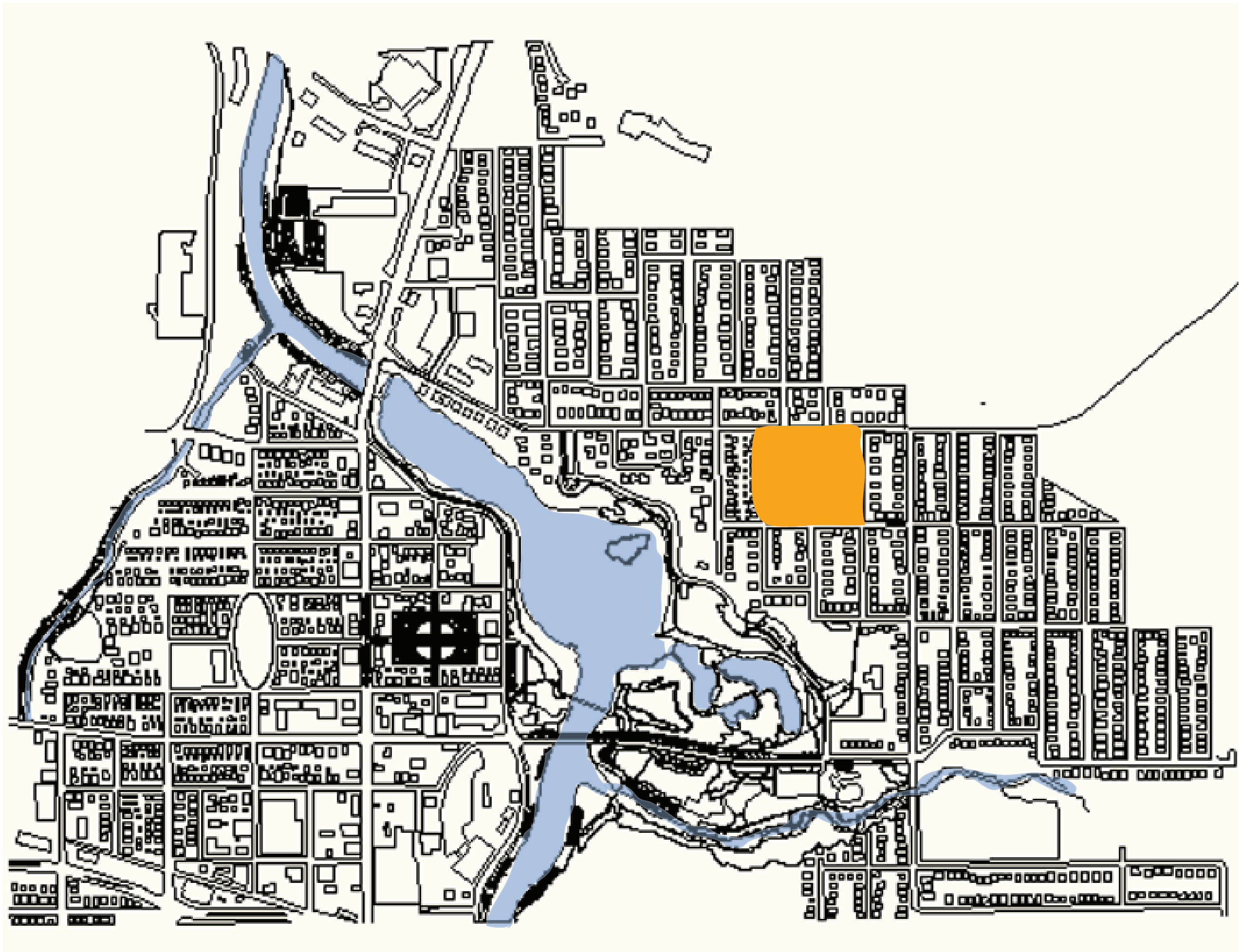
Boston Ivy provides a vertical landscape if properly situated. A site with consistent moisture and a silt to clay soil structure are essential. Boston ivy will only cause brick facade damage in the long-term if these conditions are not met in the initial design.

Composting:

Composting bins designed at 5 ft x 10 ft x 2 ft provide an area to recycle resources for potential site users. The structures are elevated to 2 ft to provide seating and prevent any rabbit damage to vegetable crops.

NEIGHBORHOOD:

Jefferson Elementary School:



Jefferson Elementary School, along with many public and private schools have excessive lawns. Schools are already centrally located within specific demographics, which makes them an ideal green space to promote naturalized plantings, rain gardens and urban fruit production. Jefferson Elementary serves as an illustration on what public green spaces such as elementary school can become to utilize the space during multiple seasons.

NEIGHBORHOOD:

Jefferson Elementary School:

Green Schools: Fruit Plantings as Boundaries

The addition of edible landscape plants increases a public's awareness of these varieties, which can promote a neighborhood's plant diversity.

Edible Landscaping: Expanding Plant Palettes

Carmine Jewel (R) Cherry

Blue Velvet TM Honeyberry

Double Delight Raspberry

Visual impulse develops when residents are exposed to urban fruit plantings in public landscapes.

It challenges a contemporary landscape's status quo by **integrating fruit production with aesthetics.**

NEIGHBORHOOD:

Urban Forest: Plant Diversity

Engaging the community to expand the diversity of our urban forests is essential to a **landscape's long-term health.**

Plant Diversity's Impact:

Frank S. Santamour, Jr. of the U.S. National Arboretum recommends **30-20-10-5 guidelines for tree diversity:**

I.e. **Autumn Blaze (R) Freeman Maple**

(1) plant no more than **30%** of any **Family**
Aceraceae - Maple

(2) plant no more than **20%** of any **Genus**
Acer

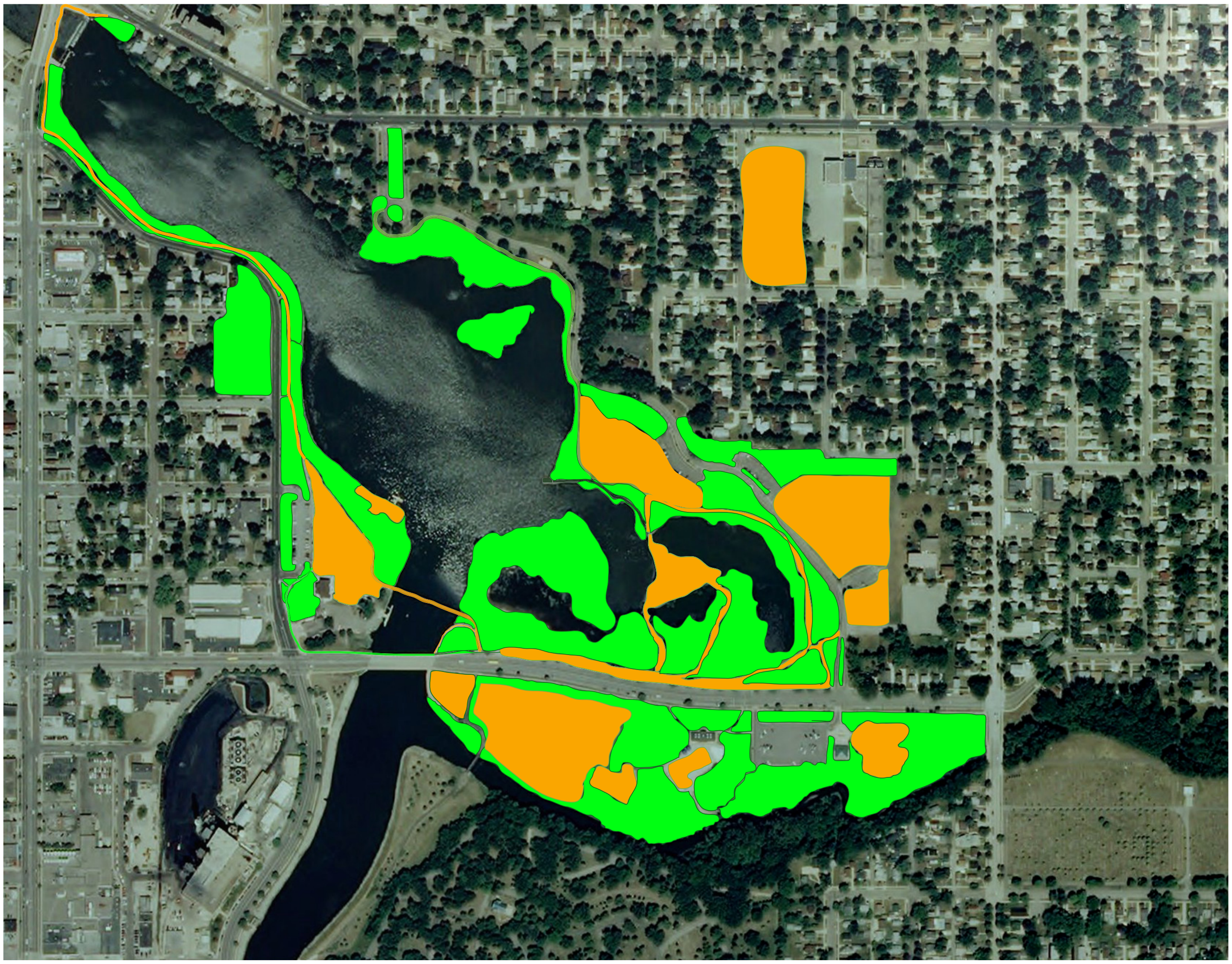
(3) no more than **10 %** of any **Species**
freemanii

*(4) no more than **5%** of any **Cultivar.**
Autumn Blaze (R)
(Santamour, 1992). * Dr. Herman recommendation

Historical Repetition: **Dutch Elm Disease & Emerald Ash Borer**

NEIGHBORHOOD:

Silver Lake Park: Existing Active & Passive Landscape Spaces

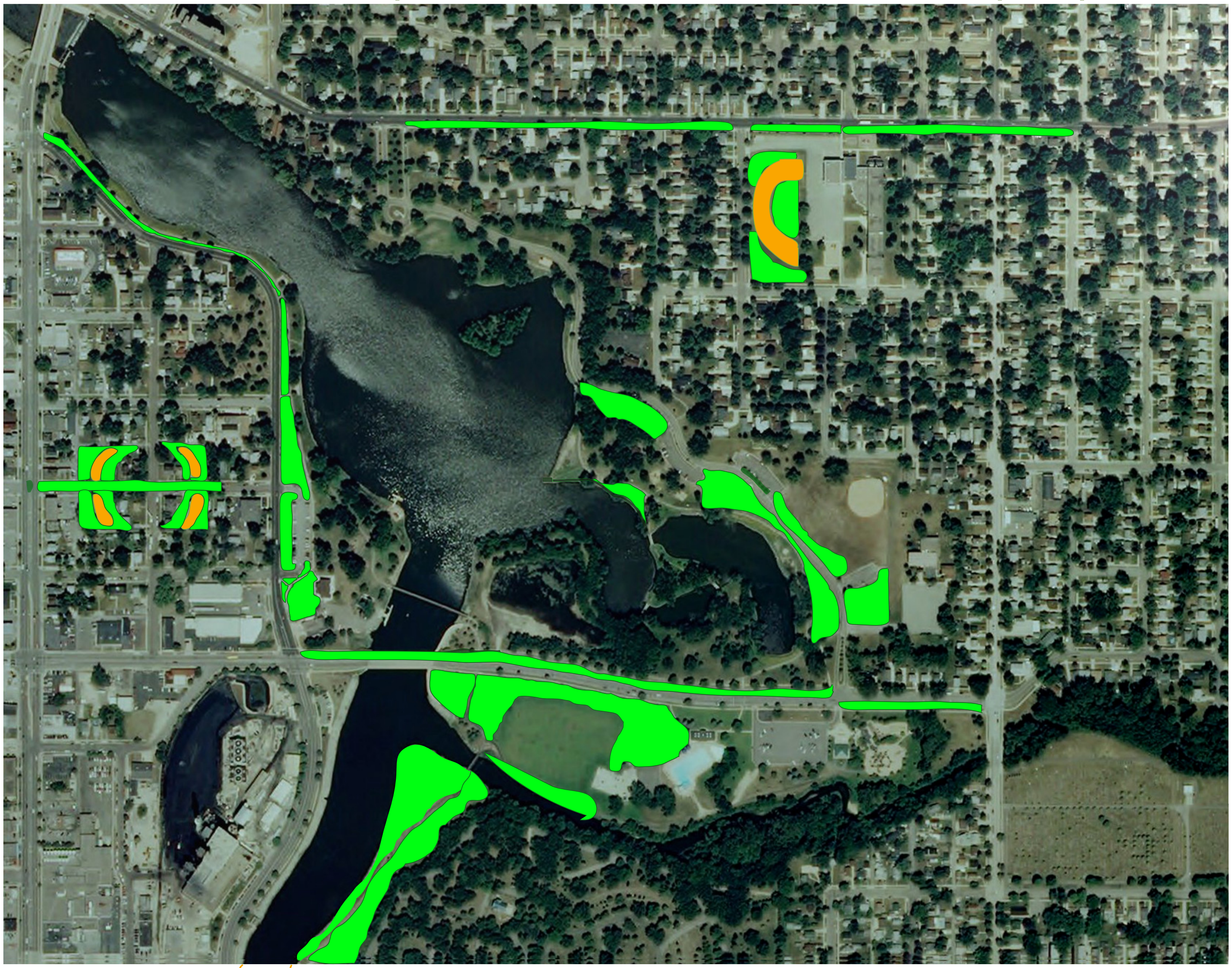


Active Spaces: Recreational Trails & Activities

Active and passive green spaces expand into the Glendale and Northrop neighborhoods. A balance is necessary between naturalized plantings and **kentucky bluegrass turf** for both site users and wildlife.

NEIGHBORHOOD:

Silver Lake Park: Proposed Active & Passive Landscape Spaces



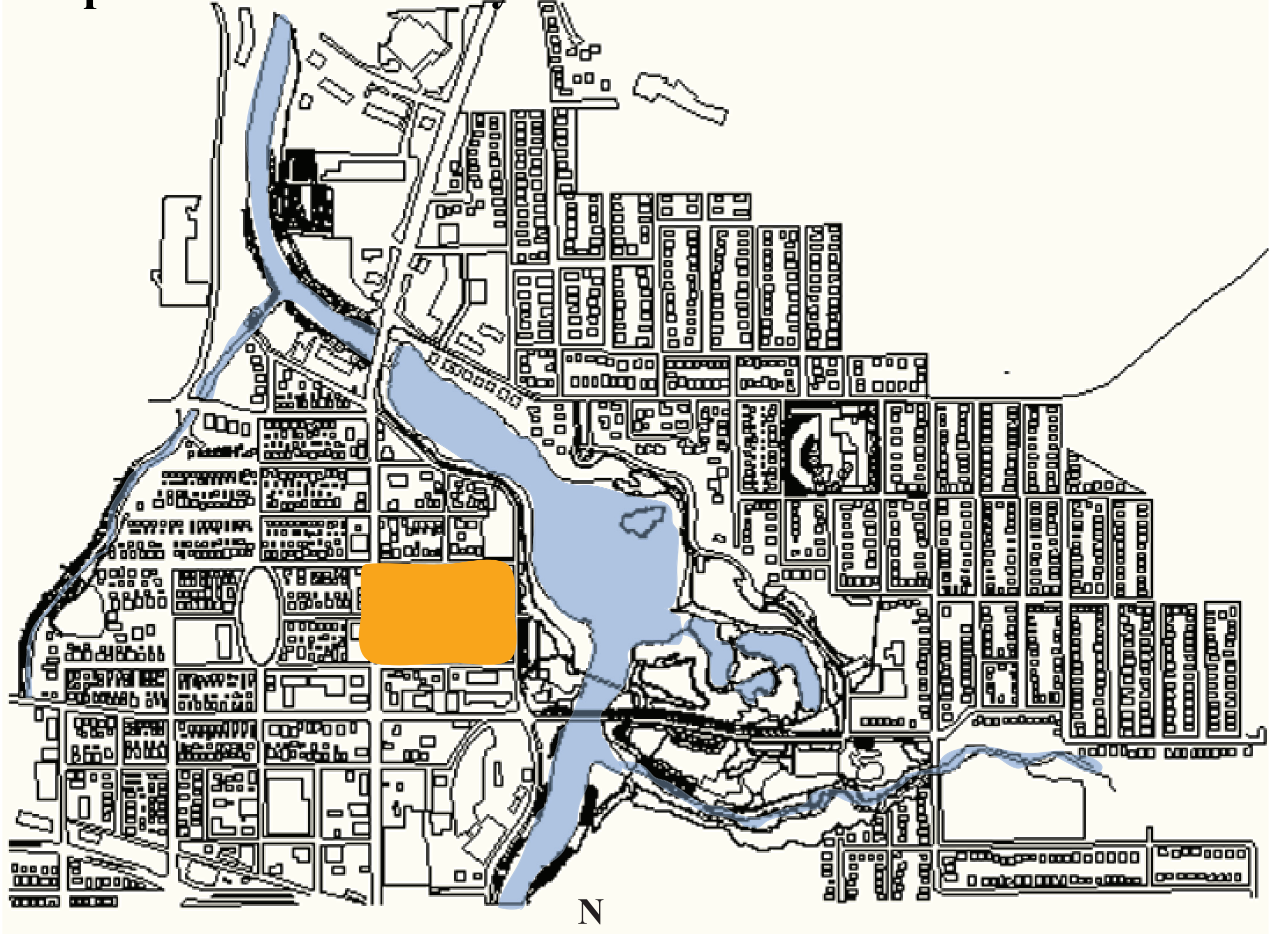
Passive Spaces: Naturalized Plantings & Minimal Used Lawn

Existing conditions promote a desirable environment for **minimal animal species**, which can be significantly improved through a wider palette of trees, shrubs and perennials.

NEIGHBORHOOD:

Silver Lake Park: Existing Active & Passive Landscape Spaces

Biophilic oriented lifestyles:



9th St. Apartments are proposed in the Northrup neighborhood directly west of Silver Lake Park. Vacant properties, neglected landscapes and excessive amount of utilities dominate the neighborhood. Neighborhood decay is a design challenge, which can be confronted by designing biophilic cities. Silver Lake Park can serve as a regional corridor which results in improving nearby neighborhoods.

NEIGHBORHOOD:

9th St. Apartments: Parking & Rain Gardens

Prospective Site Users:

U of MN College Students

Young Families

Senior Citizens

Naturalized Planting Benefits:

- Stormwater Runoff
- Attracts wildlife
- Weed Suppression
- Decreases geese populations for local residents

9**th St. Apartments** emphasize walking and biking through **green corridors.**

-1 Parking spot per apartment

Existing Lawn Conditions: 75% Weed Growth

Established Turf

NEIGHBORHOOD:

Jefferson Elementary: Edible Shrubs & Perennials

Public schools are existing components of an urban landscape that can easily implement **community gardens and edible landscaping.** Children along with surrounding neighbors are able to enjoy a landscape, which is used for food production and wildlife attraction.

Aronia melanocarpa

Fragaria x 'Seascape'

Lonicera edulis 'Borealis'
Lonicera edulis 'Berry Belle'

Malus x 'Dolgo'

Prunus cerasus 'Evans Bali'

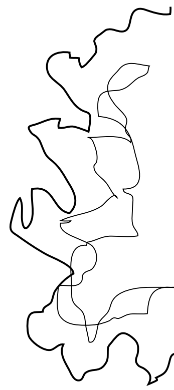
Ribes rubrum 'Red Lake'

Rubus idaeus 'Double Delight'

Vaccinium x 'Northblue'
Vaccinium x 'Northcountry'

NEIGHBORHOOD:

Jefferson Elementary: Master Plan & Design Solutions



Design Challenge:

- Seasonal use of public school green spaces.

Strengthen school green spaces through edible landscaping and a community garden. Everyone is paying taxes towards public school; therefore, providing an additional public benefit.

Design Solutions:

1. Educate elementary students.

2. Wildlife habitat and food sources.

3. Establish naturalized plantings.

4. Demonstrate community gardens.

5. Promote urban fruit production.

NEIGHBORHOOD:

Jefferson Elementary: Rain Gardens & Raised Planters

Potential Rain Garden:

Naturalized plantings and rain gardens expose children to a diverse plant palette at a young age.

Nature can indirectly have **long-term benefits** in promoting a renewed interest in public green spaces.

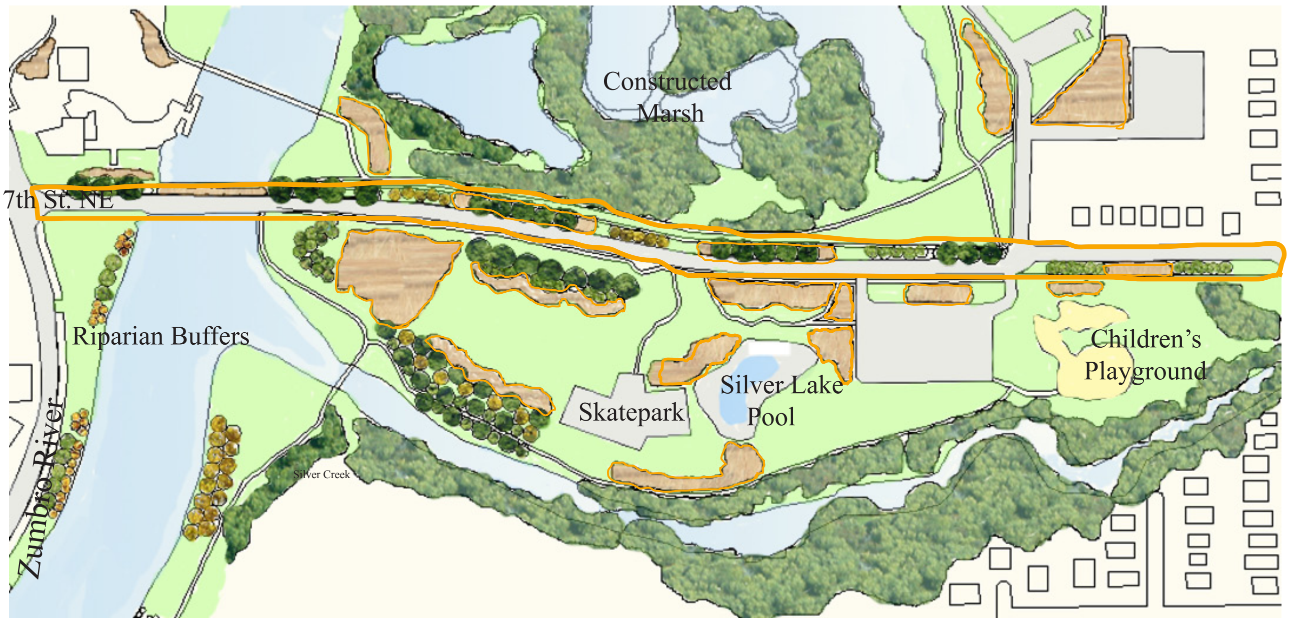
Community Garden: Raised Planters

Public school green spaces can implement simple design interventions to benefit children and neighborhoods.

1. **School/ neighborhood garden.**
2. **Naturalized plantings** with **fruiting shrubs** and **perennials.**
3. **Rain garden demonstration area.**

NEIGHBORHOOD:

South Silver Lake Park: Master Plan




Naturalized Plantings


Turfgrass

N

0’ 200’ 400’


Excessive Lawn:

Design Challenge:

- Weak pedestrian crossing along 7th St. NE.

Improve existing **‘overengineered’ street** by narrowing 4 lanes of traffic down to 2 lanes.

Design Solutions:

1. Design narrow, pedestrian oriented streets.

2. Establish riparian buffers and wildlife habitat.

3. Provide naturalized plantings reminiscent of a forest clearing.

4. Balance active and passive spaces.

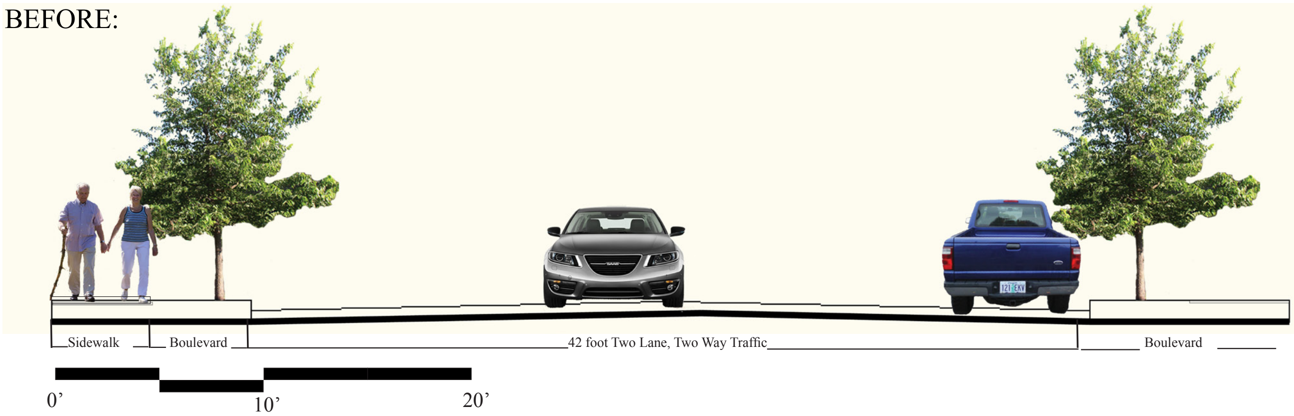
5. Expand existing biodiversity.


Forest Clearing:

STREET:

Silver Lake Park: Narrowing 7th St. NE

BEFORE:

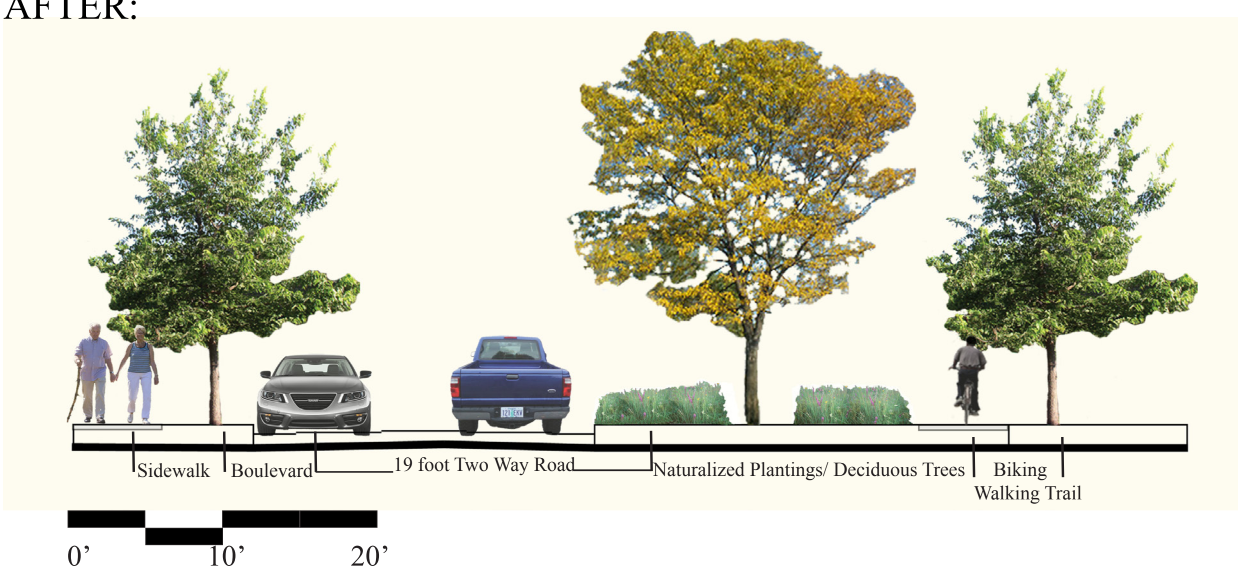


7th St. NE has **disproportionate pedestrian** and **vehicular traffic**. It divides Silver Lake Reservoir from the Silver Lake skatepark, swimming pool and children’s playground.

The road reduction by 23 feet allows a strong buffer between vehicular and pedestrian traffic. Narrow streets,

1. **Decrease stormwater runoff.**
2. **Reduce fragmented landscapes.**
3. **Decrease pedestrian/ vehicular casualties.**

AFTER:

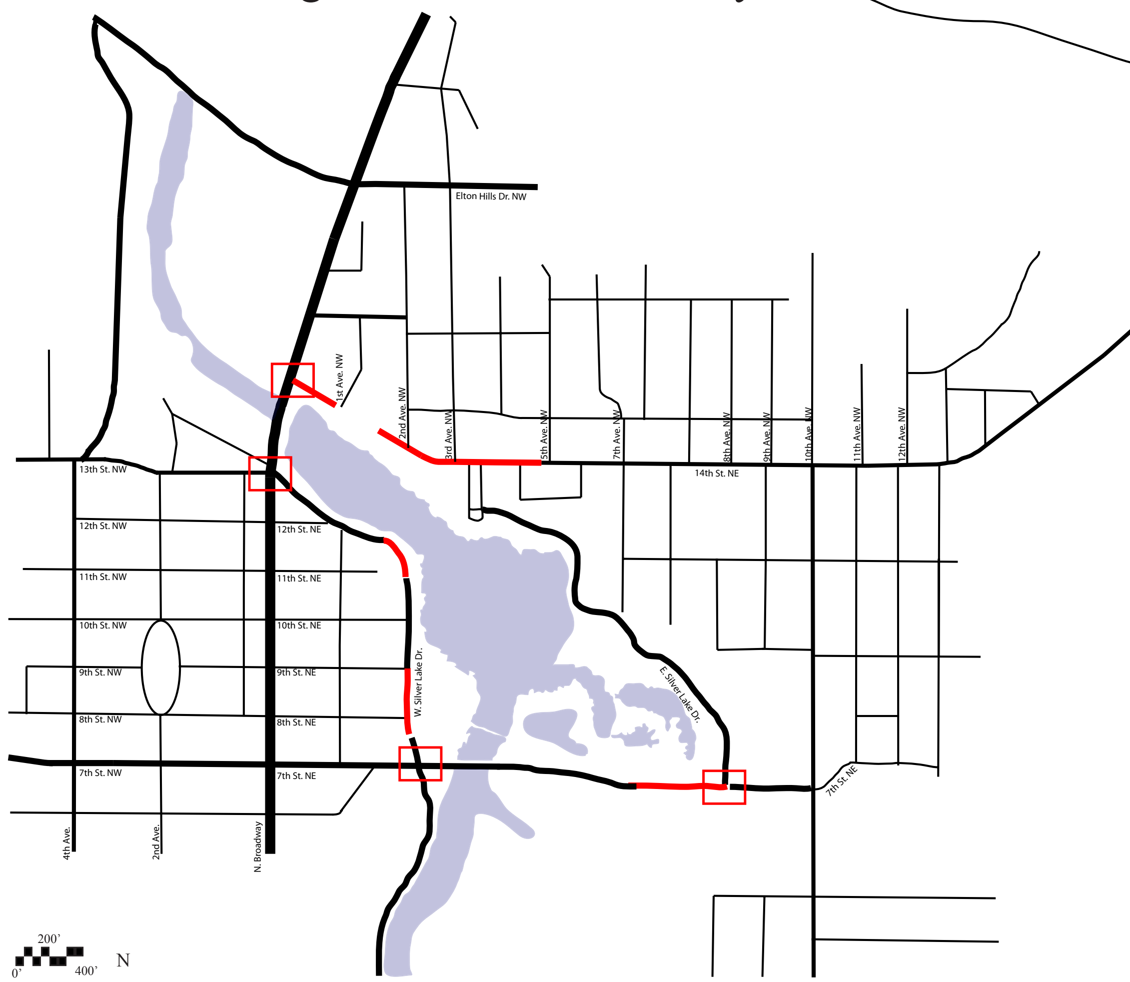


STREET:

Silver Lake Park: Narrowing 7th St. NE

BEFORE: Overengineered Road= Casualties

Silver Lake Neighborhood Street Analysis:



STREET:

Silver Lake Park: Narrowing West Silver Lake Dr.

Design Challenge:

- West Silver Lake Dr. has increased speeding incidents in a **30 mph** public road.

Narrow roads **maximize green space** while allowing people to consciously believe they may hit something if driving faster than allotted speed limit.

AFTER: Naturalized Plantings= **Reduced geese population**

Naturalized plantings are established along West Silver Lake Dr. to promote an undesirable environment for giant Canadian geese. Indigenous forbs and grasses are proposed, which would be site specific and expand Silver Lake's biodiversity.

STREET:

Existing Conditions: Vacant Houses, Neglected Landscapes & Excess Utilities

Existing Conditions: Vacant Houses, Neglected Landscapes & Excess Utilities

PROBLEM:

1. House vacancies

2. Geese invading residential lawns

3. Low Pedestrian Traffic

4. Poor connection to North Broadway.

SOLUTION:

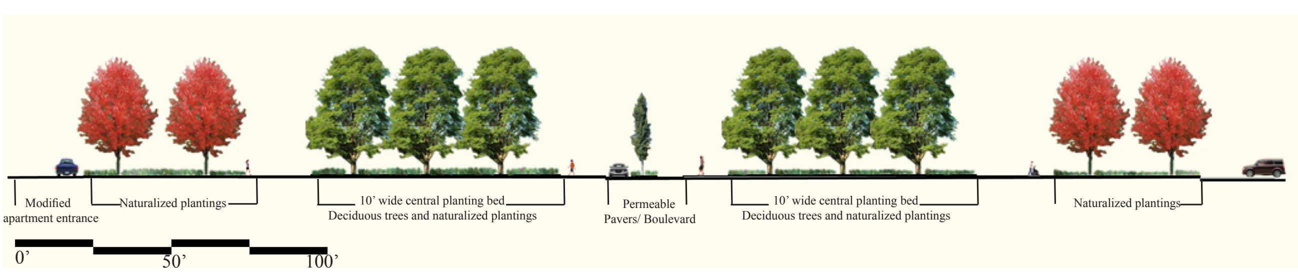
1. Increase housing density from low to medium density.

2. Naturalized plantings and reduced turf.

3. Connect fragmented public green spaces.

4. Establish a pedestrian green corridor

9th St. Pedestrian Corridor: N. Broadway to W. Silver Lake Dr.



STREET:

Pedestrian Corridor: North Broadway to Silver Lake Park

Proposed Deciduous Trees:

Acer x freemanii 'AF#1'
Firefall TM Freeman Maple

Amelanchier grandiflora
Autumn Brilliance (R) Serviceberry

Celtis 'JFS-KSU1'
Prairie Sentinel (R) Hackberry

Gymnocladus dioicus 'Stately Manor'
Stately Manor Kentucky Coffeetree

Malus x 'Jarmin'
Marilee (R) Crabapple

Quercus macrocarpa 'JFS- KW3'
Urban Pinnacle (R) Bur Oak

BLOCK:

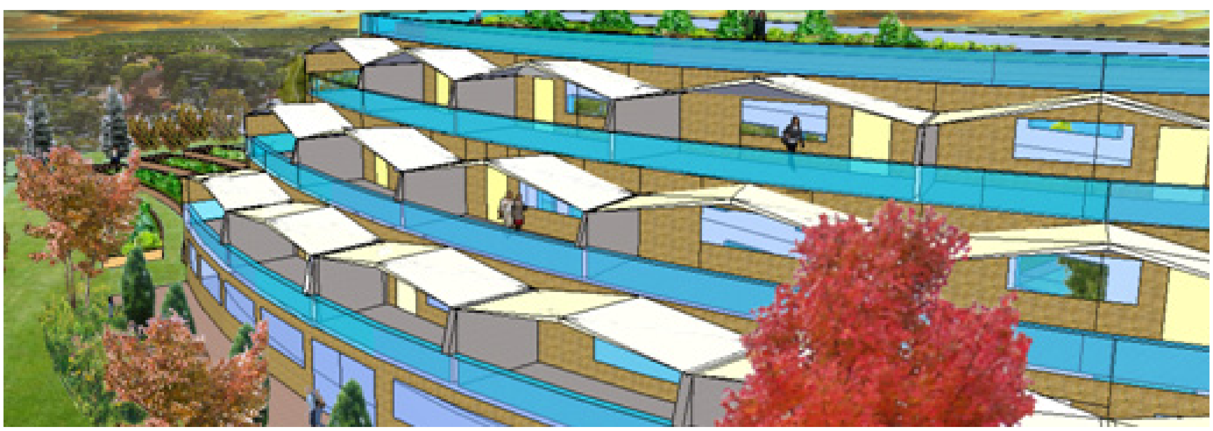
Northbrook Apartments: Naturalized Plantings

Northbrook Apartment East Entrance:

Naturalized Plantings Defining Space:

Site specific plant compositions provide multiseasonal appeal for apartment tenants.

The apartment's appearance **contradict many contemporary designs**, which focuses mostly on architecture.



Proposed Northbrook Apartment Balcony Perspectives:

Apartment tenants have **framed views** to the Zumbro Riverfront along with adaptable plantings.

Western light exposure maximizes an ideal growing environment for growing vegetables on each tenant's balcony.

Green Plaza: Silver Lake Park to North Broadway

9th St. Apartment Benefits:

- **Pedestrian oriented streets.**

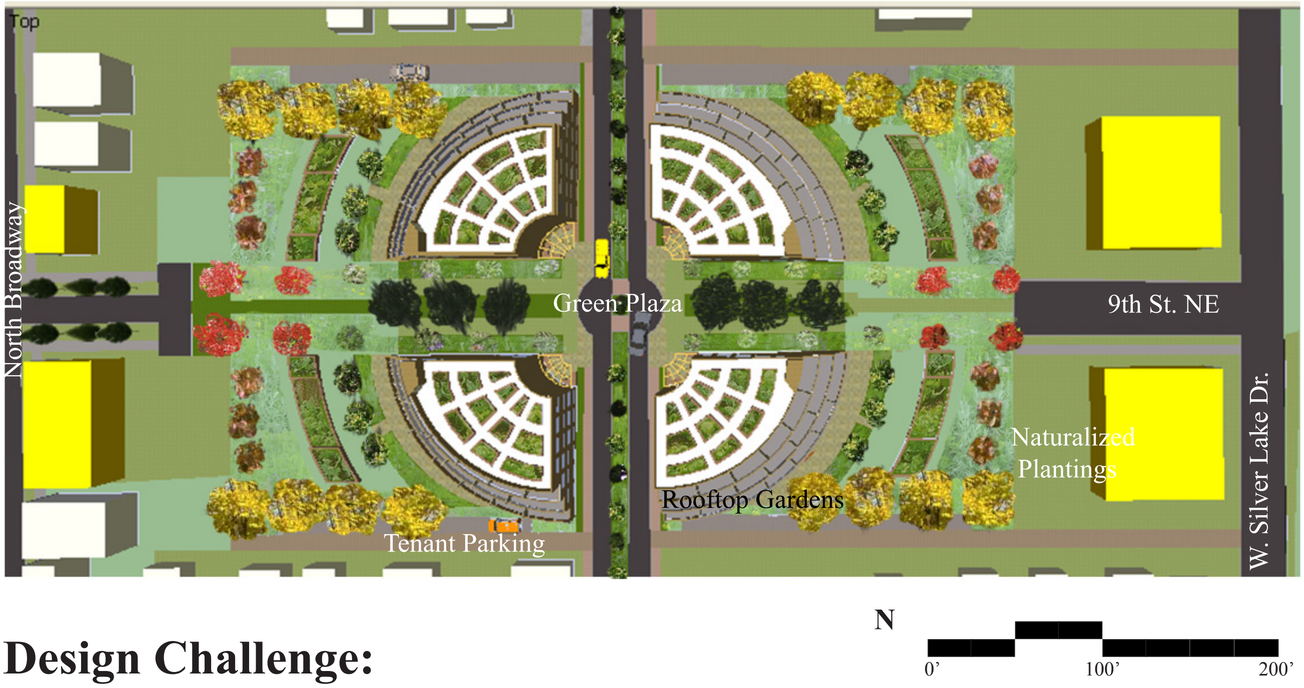
- **Direct access** to Silver Lake Park & North Broadway corridor.

- **Convenient drop-off site** for aparment tenants for loading and unloading groceries, furtniture, etc.

- **Decreased pedestrian, bike & vehicular casualties.**

BLOCK:

Proposed 9th St. Apartments: Master Plan



Design Challenge:

- No direct pedestrian connection to North Broadway and surrounding public green spaces.

Incorporate medium density housing to increase Silver Lake's site users. Convert portions of 9th St. NE into a **green plaza** to **enhance Silver Lake Park's entrance.**

Apartment Rooftop Garden:

Design Solutions:

1. Convert 9th St. NE into a green plaza for neighborhood residents.

2. Attract young families, students and senior citizens to experience a 'green' lifestyle.

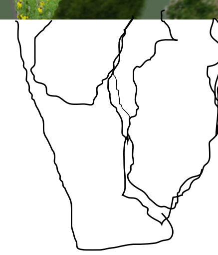
3. Minimize turfgrass to alleviate geese problems.

4. Create a pedestrian oriented green corridor.

5. Provide personal green spaces (patios) and an apartment community green rooftop.

BUILDING:

9th St. Apartments: Private Rooftop Gardens



Green Rooftop Benefits:

- **Private greenscape** for apartment tenants.

- **Scenic views** of surrounding neighborhood.

- **Desirable amenity** for local residents desiring a **biophilic oriented lifestyle** at an affordable price.

- Utilizes existing infrastructure for **food production.**

BUILDING:

9th St. Apartments: Private Rooftop Gardens

Food Production:

Container gardening allows residents to **maximize food production** for annual cool and warm season vegetables.

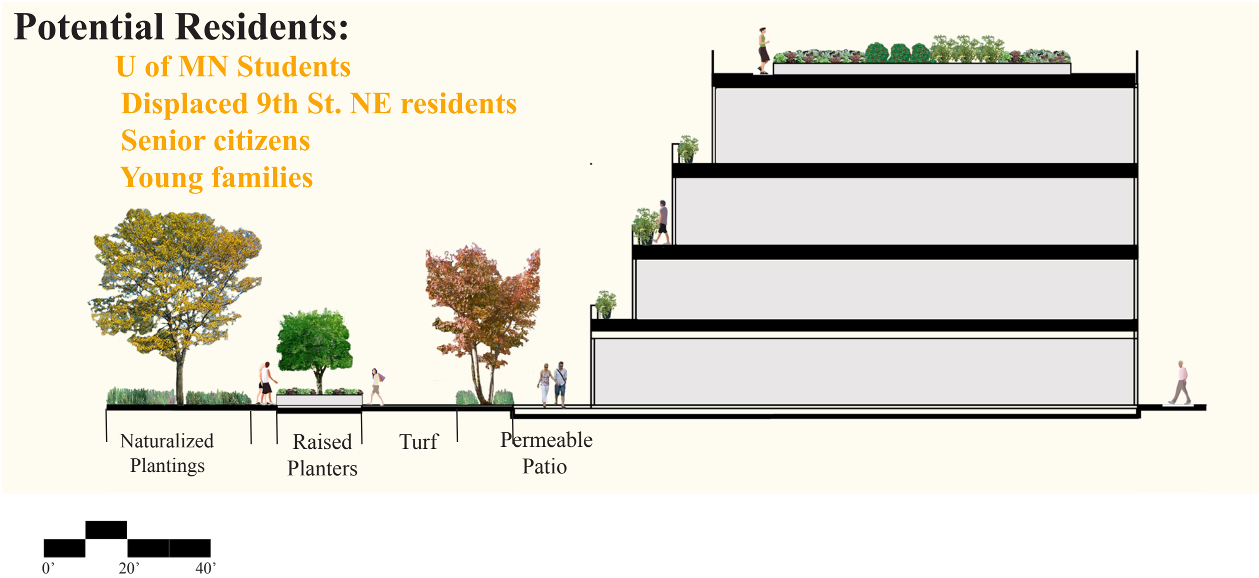
Vegetables are then easily accessible directly outside their apartments.

Apartment Rooftop Garden:

Residents have their own **personal 5 foot by 12 foot porch** for growing vegetables. A majority of the proposed apartments receive direct eastern, southern and western light for optimal plant and vegetable performance.

BUILDING:

9th St. Apartments: Landscape & Building Section



2010 Downtown Rochester Master Plan Guidlines:

9th St. NE Apartments would coincide with the 2010 Downtown Rochester Master Plan development. However; the apartments are **less than a mile northeast of downtown** for residents to walk, bike or bus.

BUILDING:

9th St. Apartments: Balcony & Patio Perspectives

Second Floor Balcony View to Garden: Korean Sun Pears

Green Alleys:

- Naturalized plantings for **contaminant removal.**

- **Vehicular and bike access.**

- **Ecological corridor.**

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"NDSU has allowed me to expand my interest in plant diversity through a double major in Landscape Architecture and Horticulture."